CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

MINES BRANCH
INDUSTRIAL MINERALS DIVISION

INDUSTRIAL WATER RESOURCES OF CANADA

WATER SURVEY REPORT NO. 9

Churchill River and Mississippi River

Drainage Basins In Canada, 1952-54

By
J. F. J. Thomas

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
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3,500-1957—955

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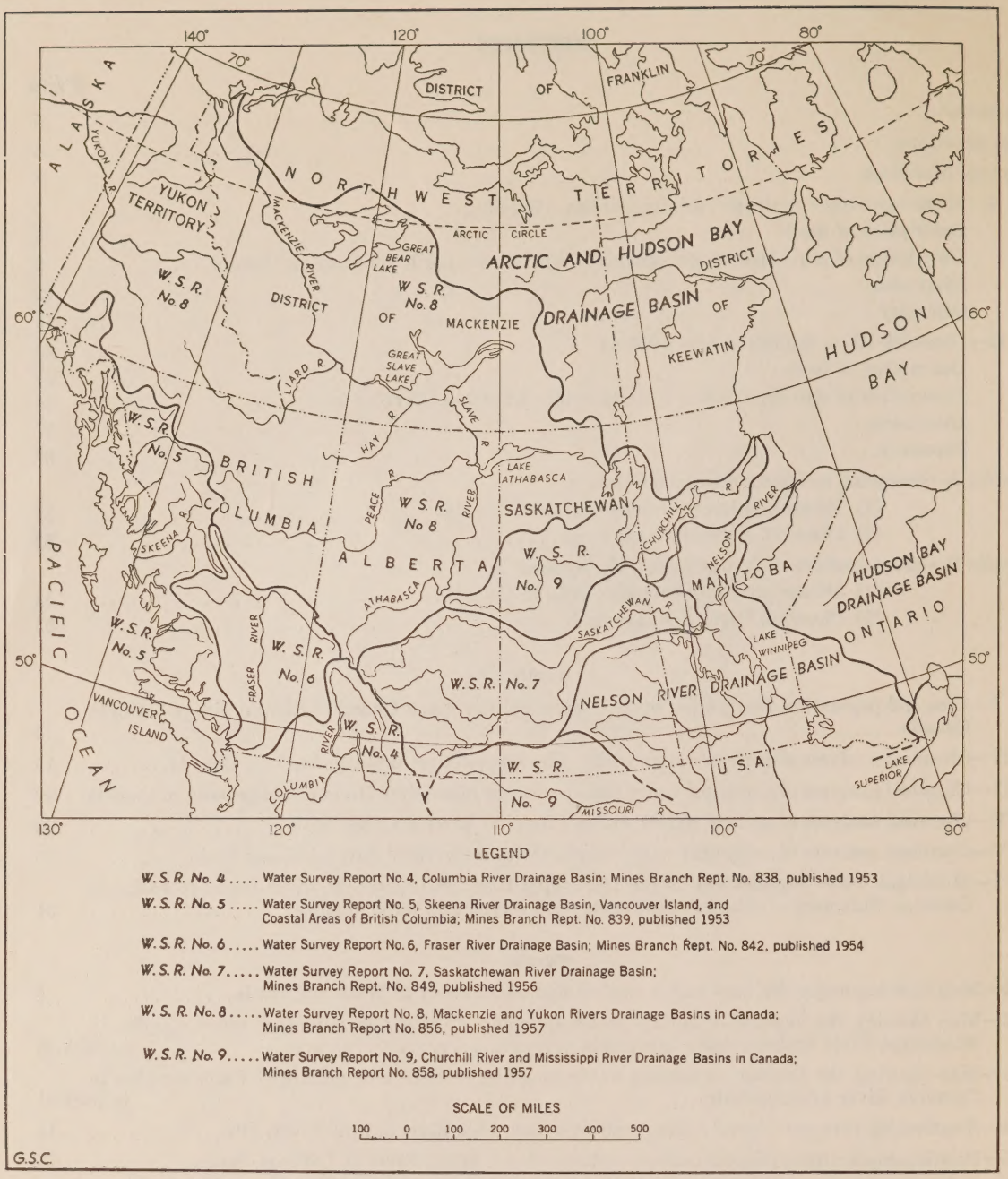

LEGEND

W. S. R. No. 4 ..... Water Survey Report No. 4, Columbia River Drainage Basin; Mines Branch Rept. No. 838, published 1953

W. S. R. No. 5 ..... Water Survey Report No. 5, Skeena River Drainage Basin, Vancouver Island, and Coastal Areas of British Columbia; Mines Branch Rept. No. 839, published 1953

W. S. R. No. 6 ..... Water Survey Report No. 6, Fraser River Drainage Basin; Mines Branch Rept. No. 842, published 1954

W. S. R. No. 7 ..... Water Survey Report No. 7, Saskatchewan River Drainage Basin; Mines Branch Rept. No. 849, published 1956

W. S. R. No. 8 ..... Water Survey Report No. 8, Mackenzie and Yukon Rivers Drainage Basins in Canada; Mines Branch Report No. 856, published 1957

W. S. R. No. 9 ..... Water Survey Report No. 9, Churchill River and Mississippi River Drainage Basins in Canada; Mines Branch Report No. 858, published 1957

SCALE OF MILES

100 0 100 200 300 400 500

G.S.C.

FIGURE 1. MAP SHOWING DRAINAGE BASINS UNDER STUDY IN WESTERN CANADA

INDUSTRIAL WATER RESOURCES OF CANADA

Chemical Quality of Surface and Municipal Water Supplies in the Churchill River and Mississippi River Drainage Basins in Canada, 1952-54

INTRODUCTION

This ninth report in the series of Water Survey Reports on the chemical quality of surface and municipal water supplies available for industrial and domestic use in Canada, covers the drainage basins of the Churchill River and of the Mississippi River in Canada. Report No. 1[1] outlines the aim, scope and procedures of the country-wide survey begun in 1947 and discusses, with the assistance of tables and graphs, the interpretation and analytical results to be recorded in subsequent reports of the series. Reports No. 2[2] and 3[3] record in detail the results of studies on the Ottawa River and Upper St. Lawrence River-Central Great Lakes drainage basins respectively.

This report and previous reports, Nos. 4 to 8 inclusive, cover the areas and drainage basins of western Canada shown in Figure 1, and include all of western Canada except those areas of Manitoba and Saskatchewan drained by the Nelson River system (exclusive of the Saskatchewan River tributary basin) and the northern portion of western Canada, (exclusive of the Mackenzie River basin) draining into the Arctic Ocean and Hudson Bay.

The Nelson River drainage basin will be reported in Water Survey Report No. 10, now in preparation. The remaining unreported area draining into the Arctic Ocean and Hudson Bay is at present almost undeveloped, generally inaccessible except by aircraft and inhabited only by a few trappers, Indians and Eskimos. Studies of water quality in this area will therefore be very limited and have been delayed until areas of greater industrial importance have been studied and reported.

The method of presentation of data in this report is similar to that of previous reports and no attempt has been made to discuss in detail all the information recorded herein or obtained during the survey. Part I outlines the results of studies in the Mississippi River drainage basin during 1952-53 and Part II records the results of similar studies in the Churchill River basin during 1953-54.

The cooperation of municipal officials and waterworks engineers within these basins who supplied information on their waterworks systems by correspondence, or to engineers of this Division during visits to their communities, is gratefully acknowledged.

As in previous reports information received from district engineers of the Water Resources Division, Department of Northern Affairs and National Resources was of great help in selecting suitable sampling locations and collectors. Most of the data on river and lake stage and river discharge used in this report were also supplied by them. The reader is referred to the Water Resources Papers of the above Department, in particular those covering the Arctic and Western Hudson Bay drainage basin for additional data on river discharges and lake stages.

Industrial Water Resources of Canada—Department of Mines and Technical Survey, Ottawa.

[1] *Water Survey Report No. 1.* Scope, Procedure and Interpretation of Survey Studies. Mines Branch Report No. 833, 1952.

[2] *Water Survey Report No. 2.* Ottawa River Drainage Basin. Mines Branch Report No. 834, 1952.

[3] *Water Survey Report No. 3.* Upper St. Lawrence River-Central Great Lakes Drainage Basin. Mines Branch Report No. 837, 1954.

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TABLE I

Area and Population Distribution in Mississippi River and Churchill River Drainage Basins in Canada

Drainage basin	Approximate area drained, square miles				Per cent of total area drained in			Estimated population in hundreds in area					Percentage of total population in basin areas			
	Alta.	Sask.	Man.	Total	Alta.	Sask.	Man.	Census Date	Alta.	Sask.	Man.	Total	Alta.	Sask.	Man.	Total
Nelson River[1] including Saskatchewan River Basin..	80,655	115,095	132,760	328,510	31.6	45.7	53.8	1956	9,630	7,886	8,395	25,911	85.7	89.5	98.8	90.8
								1951	7,949	7,464	7,689	23,102	84.6	89.7	99.0	90.7
Mackenzie River.....	162,855	50,815	0	213,670	63.8	20.2	0	1956	1,260	43	0	1,303	11.2	0.5	0	4.6
								1951	1,181	11	0	1,192	12.6	0.1	0	4.7
Hudson Bay.....	0	2,105	79,075	81,180	0	0.8	32.1	1956	0	0	52	52	0	0	0.6	0.2
								1951	0	0	37	37	0	0	0.5	0.1
Mississippi River[2].....	5,005	17,150	0	22,155	2.0	6.8	0	1956	89	599	0	688	0.8	6.8	0	2.4
								1951	92	602	0	694	1.0	7.3	0	2.7
Churchill River.....	6,770	66,535	34,680	107,985	2.6	26.5	14.1	1956	252	279	53	584	2.3	3.2	0.6	2.0
								1951	173	240	39	453	1.8	2.9	0.5	1.8
Total.....	255,285	251,700	246,515	783,500	100	100	100	1956	11,231	8,807	8,500	28,538	100	100	100	100
								1951	9,395	8,317	7,765	22,478	100	100	100	100
Percent of total Canada.....	6.6	6.6	6.4	19.6	.....	.....	.....	1956	6.9	5.5	5.3	17.7	.....	.....	.....	.....
								1951	6.7	5.9	5.5	18.2	.....	.....	.....	.....

[1] Includes a portion of Hudson Bay drainage basin near mouth and certain areas having no drainage.

[2] Includes Johnstone Lake area, etc.

SURVEY PROCEDURE

The methods of sampling and general survey procedure employed in the investigations in both areas covered by this report were essentially the same as those used in previous survey studies, and are outlined in detail in Water Survey Report No. 1.

In 1951 when field studies were underway in the Saskatchewan River drainage basin (Water Survey Report No. 7) nine sampling stations were established on rivers within the Mississippi River drainage basin in Canada.

Monthly samples were collected, insofar as possible, from these nine stations usually over the period February 1952 to January 1953 inclusive and shipped directly to the analytical laboratory at Ottawa.

In 1952 when field studies were under way in the Mackenzie River and Mississippi River basins several sampling locations were established in that part of the Churchill River drainage basin accessible by road. Additional stations were established later by correspondence so that a total of thirteen stations, nine operating

monthly, the remainder bi-monthly or quarterly were in operation during the period March 1953 to February 1954 inclusive. Several of these stations were established and samples collected by the Churchill River Power Company Limited, Winnipeg, Man., and the assistance of this company is gratefully acknowledged. A number of samples were also collected by personnel of the Winnipeg office of the Water Resources Division, Dept. of Northern Affairs and National Resources during air flights into otherwise inaccessible portions of the basin. Coverage in these almost inaccessible areas is rather limited as regular shipping facilities are not available and the severe winter conditions often prevented sampling during this period.

No daily sampling stations were operated in either river basin but extra samples were requested at periods of high and low water at each sampling station.

During the summers of 1952 and 1953 the usual field studies were carried out in the accessible parts of each basin by engineers of this Division using a mobile laboratory. At these times additional samples of surface waters and of all known municipal water supplies were collected and partly analysed. Some of these field test results are reported in Tables II, III, IV and V in brackets beside or below the results of laboratory tests carried out at a later date at Ottawa. These field tests indicate any significant changes in water quality due to storage during shipment and prior to laboratory analysis.

Field studies included visits to most of the municipalities in the basins having organized waterworks systems, at which time information on the operation of these systems was obtained and samples of the civic waters before and after treatment, collected.

Analytical data on some waters in these basins have been received from other sources, including several Canadian water-treatment firms and a few of these analyses have been included in this report. The cooperation of these firms in supplying these data is greatly appreciated. The efficient use of water for many purposes depends to a considerable extent on a knowledge of its quality: therefore the more data available the more useful these reports are.

ANALYTICAL PROCEDURE

The methods of analyses and of recording analytical results employed in investigations in these basins were essentially the same as those outlined in Water Survey Report No. 1. It is pointed out, however, that since initiation of the country-wide survey in 1947 there have been a number of significant advances in analytical methods and these have, insofar as possible, been studied and if desirable been used in these studies.

Most of these changes have been recorded in previous water survey reports, particularly Water Survey Report No. 7. During the period that studies were under way in the Churchill River drainage basin an additional test, that of "oxygen consumed by potassium permanganate" was set up as laboratory routine on surface water samples. This test which appears in *Standard Methods*[1] gives some further information on organic content including colouring matter. Also, in the latter part of 1954 the determination of trace elements, in particular aluminum and manganese, was set up as routine on all waters. In order to carry out these additional tests, and tests for copper, zinc and ammonia, which were begun later, some other tests were deleted on certain samples, for example "residue on evaporation @ 105° C."

During the period of this report considerable work was carried out on several newer analytical methods in an attempt not only to increase accuracy but also to lessen the analytical work involved. Studies on the determination of sulphate ion in water were rather extensive since the usual gravimetric method is time-consuming and not altogether satisfactory for the determination of the low amounts of sulphate usually found in waters of the Churchill River basin. Since about June 1954 most sulphate determinations have been carried out using a turbidimetric procedure and many of the values reported on waters in the Churchill River basin were so determined. Work is proceeding on the development of a volumetric procedure for the routine determination of low sulphate concentrations.

No "averages" have been calculated on waters in this report. As previously pointed out such averages must be carefully interpreted, especially when water quality has the wide variation found in the Mississippi River basin. True averages should be based on numerous samples, weighted as to flow. In these basins, lack of flow records, wide variability in flow and quality and in certain areas failure of the regular sampling schedule has made an unweighted average of little value.

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[1] Standard Methods for the Examination of Water and Sewage, 9th Edition (1946)—American Public Health Association, 1790 Broadway, New York 17, N.Y.

Per cent sodium and saturation index have been calculated as routine on all waters and are reported (*see* Water Survey Report No. 1 for interpretation of these calculated values). In this report stability index is also reported. This value, ($2pH_s - pH$), has somewhat the same meaning as saturation index but is claimed to be more useful as an indication of the corrosive or scaling tendency of a water. Scaling increases when the stability index is 6·0 or less and corrosion becomes a problem when the index is above 7·5 or 8·0.

Dissolved oxygen is not determined on surface waters because it varies so widely with sampling location and depth, seasons, etc. and in most rivers it is near saturation. Carbon dioxide is also a variable quality which must be determined on the spot at the time of sampling. It can be calculated from the analytical data supplied, but if so done, it is the carbon dioxide content of the water at the time of testing for pH and alkalinity, and not necessarily that in the water at the time of sampling.

PART I

Mississippi River Drainage Basin in Canada

DESCRIPTION OF BASIN

The Mississippi River system, the largest on the North American continent also drains a small part of Canada to the Gulf of Mexico. Actually smaller tributary rivers and creeks drain this area of Canada into the Missouri River, a major tributary of the Mississippi River.

Figures 1 and Table I show the location and extent of this drainage area. The area is small even when, as has been done in this report, some local or closed drainage areas such as that of Johnstone Lake are included in the Mississippi River system, namely a total of about 22,155 square miles, 17,150 in Saskatchewan and 5,005 in Alberta. The entire basin represents only 2·9 per cent of the total area of the prairie provinces and only about 4·4 per cent of all Saskatchewan and Alberta.

This area lies within the Interior Plains region and parts of it are classed as "badlands". These have developed as a result of easy erosion of soft beds, overlain usually by more resistant sandstones or shales. The land becomes deeply dissected by sharp valleys between knobs or hills of variable size, heights and shapes which are almost entirely devoid of vegetation. While such badlands do not occupy large areas they are present in this basin along Milk River in Alberta and in an area in Saskatchewan near the International Boundary south of Wood Mountain Plateau, along the Lake-of-the-Rivers and Big Muddy valleys, and along Frenchman River near East End. "In this area an escarpment known as the Missouri couteau forms the eastern boundary of Wood Mountain Plateau and a northwest extension from it. The rise is 200 to 500 feet but as there is an equal drop to the west the escarpment does not represent a rise from one prairie level to another: it disappears to the northwest but in the south is locally a prominent feature"[1].

This drainage area generally lacks rainfall and suitable ground water. "Many of the rivers are cut well below plains level occupying wide valleys which are mostly flat bottom lakes with steep banks. Valleys that once contained large streams are now dry, or are occupied only by minor streams in wet seasons or by remnants of former lakes, now alkaline and without outward drainage. In other parts alkaline lakes fill shallow depressions below prairie level and are completely surrounded by slightly higher lands. In dry periods these lakes either dry completely, leaving white alkaline flats from which the salts are scattered by winds over adjoining uplands in white dust storms, or they dry in part, leaving a white salt fringe as a rim around the lake shores"[1]. Several of these larger lakes, Lake-of-the-Rivers, Lake Frederick, Lake Chaplin, were sampled and are reported in Table III.

In parts of the basin the land is fertile and agriculture is carried on if rainfall or suitable water is available. In recent years control of rivers by impounding dams and networks of irrigation canals have increased the usefulness of portions of this semi-arid area.

The basin is, as a result of topography and water supply, not heavily populated, the total population in 1951 being only about 69,450 or 2·7 per cent of the total prairie province population, 7·2 per cent of the population of Saskatchewan but only 1 per cent of that of Alberta.There is no major industrial activity other than production of salts such as sodium sulphate (Na_2SO_4), etc., from some of the alkaline lakes. The main activity is grain growing. There are no major cities although several small towns have organized water supplies.

DESCRIPTION OF MUNICIPAL WATER SYSTEMS IN THE MISSISSIPPI RIVER BASIN IN CANADA

Only six municipalities having organized waterworks systems were studied in 1952-53 and the data obtained are reported below under the headings—*Population served; Date of survey; Ownership of system; Source of water supply; Treatment of water supply; Storage capacity* of the system; *Consumption of water* by the municipality; and *Industrial use.*

[1] Economic Geology Series No. 1, Geology and Economic Minerals of Canada (third edition), *Geol. Surv., Canada*, No. 2478, 1947.

DESCRIPTION OF MUNICIPAL WATER SYSTEMS

Within the Mississippi River Drainage Basin in Canada

Municipality	ASSINIBOIA, SASK.			GRAVELBOURG, SASK.		
	1951	1952	1956	1951	1952	1956
Population served:						
In municipality	1,938[c]	.....	2,012[d]	1,197[c]	1,300	1,415[d]
Outside municipality	0	.....	.....	0	0	0
Total	2,000	2,150	2,012	1,200	1,300	1,415[d]
Date(s) of survey	July 3, 1952 and in 1953			July 4, 1952		
Ownership	Municipally owned and operated			Municipally owned and operated		
Source of supply	Spring run-off from Prairie Farm Rehabilitation Act dam at Willows, 6½ miles distant.			Four deep wells		
Treatment	Water from reservoir (Prairie Farm Rehabilitation Act dam) is pumped with alum-treatment through pressure filters (anthrafilt) to ground reservoirs from which it is repumped with chlorination to system.*			Water from two wells (100 and 175 feet deep) is chlorinated and pumped to concrete reservoir, then repumped to tank and system.		
Storage capacity (thousand gallons)	Two concrete reservoirs—200 P.F.R.A. dam reservoir—140,000 One standby run-off reservoir dam, 1 mile east of town—20,000.			Ground reservoir—225 Elevated tank—62·5		
	1951			1951	1952	
Consumption (average in m.g.d.)	0·070			0·035	0·040	
Industrial use	A farming community; no major industrial user			A farming community, no major industrial user.		
Remarks	*$CuSO_4$ is added periodically to reservoir (P.F.R.A. dam). Fluoridation of supply started in 1953.					

Municipality	WILLOW BUNCH, SASK.	
	1951	1956
Population served:		
In municipality	613[c]	725[d]
Outside municipality	0	0
Total	613	725
Date(s) of survey	1952	
Ownership	Municipally owned and operated.	
Source of supply	Five springs.	
Treatment	Spring water is pumped from infiltration gallery with chlorination to system.	
Storage capacity (thousand gallons)	One reservoir—38.	
	1952	
Consumption (average in m.g.d.)	0·007	
Industrial use	No major industrial user	
Remarks	System installed in 1940.	

[c] Population according to Ninth Census of Canada, 1951.
[d] Population according to preliminary data, Tenth Census of Canada, 1956.

DESCRIPTION OF MUNICIPAL WATER SYSTEMS

Within the Mississippi River Drainage Basin in Canada

MORSE†, SASK.		MILK RIVER, ALTA.		WARNER, ALTA.	
1951	1956	1951	1956	1951	1956
406[c]	453[d]	481[c]	633[d]	422[c]	445[d]
.....	.....	....	....	....	....
495	453	590	633	422	445[d]
December, 1952		July 8, 1952		1952.	
Municipally owned and operated		Municipally owned and operated		Municipally owned and operated.	
Deep well		Well, 40 feet deep		Two wells, 190 feet deep.	
No treatment; pumped to system through small pressure tank.		No treatment: well water pumped to elevated tank and system.		No treatment: water pumped to system and tank.	
None		Elevated tank—40		One tank—30.	
		1951		1951	
Not known		Not known		No information.	
No major industrial user		No major industrial user; a farming community.		A wheat-growing and ranching area; six grain elevators.	
System installed in 1931				System installed in 1951.	
†Data from Dept. of Health of Saskatchewan.					

[c] Population according to Ninth Census of Canada, 1951.
[d] Population according to preliminary data, Tenth Census of Canada, 1956.

DISCUSSION

Table I and Figures 1 and 2 clearly indicate that the part of Canada drained by the Mississippi River system to the Gulf of Mexico is very small (about 0·6 per cent of Canada's area) and that within this basin only about 0·5 per cent of Canada's population dwelt in 1951-52. However, water resources including water quality are of prime importance to this area where rainfall is so limited that parts of the basin are semi-arid.

The wide variability in water quality within the basin and with the season, noted in Table II, illustrates the semi-arid character of the area. One of the larger rivers, Milk River, rising in the foothills region of Montana, U.S.A., varies from a very hard water at periods of low flow to almost a soft water when flow is high from July to September; the principal salt in solution is calcium bicarbonate but the ratio of magnesium to calcium is often much higher than found in most Canadian rivers. As this river flows through the basin it becomes harder, mainly from calcium and magnesium sulphates, but there is also a notable increase in sodium salts. Frenchman River, one of the larger streams rising in the basin is fed by many sloughs and small creeks such as Battle Creek and it also shows wide fluctuations in quality and discharge. This river is generally very hard with a relatively high ratio of non-carbonate hardness (sulphates), and a high ratio of magnesium to calcium. Tributaries such as Battle Creek show similar variation and ratios.

Some of the smaller tributaries rising in the basin and flowing southward into the United States, such as the several branches of the Poplar River, show similar characteristics even though they do have less non-carbonate hardness. However, the high inflow of sodium sulphate from lakes and sloughs does result in a high mineral content and a high per cent sodium, ranging from 25 to 40 per cent.

Within this basin is included a number of closed drainage basins such as Johnstone Lake, Lake Frederick, etc. These, although not studied in detail, show a marked increase in the Mg:Ca ratio, in sodium sulphate and in sodium chloride and indicate that it is inflow of waters of this character from sloughs and ground water tables that influence the streams discussed above. The mineralization of these local basins or sloughs depends upon rainfall or inflow and upon rate of evaporation. Lake Frederick has become so concentrated in salts, especially sodium sulphate, that it is used as an economic source of this salt.

Notukeu Creek is typical of creeks in this semi-arid area, and shows high mineralization with a high ratio of non-carbonate hardness, a high sodium content (50 to 70 per cent) and a wide variability in quality with the season.

Figures 4 and 5 are typical graphs showing the relationship between mineral content and river flow or level in waters in this basin. Figure 4, a study of the Milk River at Milk River, Alta., shows that hardness salts are the principal dissolved matter in this stream since the curve for total hardness follows closely the curve for specific conductance (total dissolved solids). The curve of river discharge with season is almost a mirror image of the curve for conductance but does not show the lag in increasing solids with increasing flow so often noted in rivers more dependent on melting ice and snow. Milk River shows some decrease in mineralization with high discharge in the spring, and later in the summer shows another period of high discharge but with lower mineralization. This may be due to several factors; for example, early local run-off or flash floods in April may be of such short duration as to only partially dilute the river water: later, run-off from mountain snows and rainfall of water lower in total solids, while not so rapid, may continue over several months and result in a marked decrease in mineralization in the main river. In the fall as this run-off and rainfall decreases, the effect of drainage from local tributaries, sloughs, etc., into the main river is noted in increased mineralization with low discharge. Ground water inflow may have considerable effect at this time. The presence of alkali waters is also noted in the divergence of the curves for total solids and total hardness during this period.

The curve of turbidity follows the discharge very closely in this river and the high turbidity in June is further evidence of a run-off that is rapid and not necessarily high in dissolved matter. The curve of per cent sodium supports the statement that inflow in the fall is of a water high in sodium salts, as this curve increases and that for total hardness decreases.

Figure 5 graphically shows the relationship between mineral content and discharge in a river, Wood River, rising within the basin and flowing mainly in a semi-arid area. The curves clearly illustrate the wide variability in quality in this type of stream and show that, while changes in total hardness follow fairly closely those in total mineralization, there is considerable additional mineralization present. Discharge records on this river are meager but the flow appears fairly constant and low except for the spring period, March and April. High discharge and high turbidity in this period are evidence of rather extensive spring or flash floods with waters low in mineralization and total hardness in comparison with waters at other periods of the year. The per cent sodium, however, does not show as marked a decrease, indicating appreciable inflow from overflowing sloughs a nd alkali areas during the period of high run-off.

It is evident from Tables III and IV that the surface waters, with their great variability and high mineralization, are not generally suitable for municipal use as only one municipality in the basin, Assinboia, Sask., uses surface water. This supply, which is collected run-off, requires considerable treatment and the water supplied is medium hard with a relatively high mineralization, mostly sodium sulphate. The ground waters used by the remaining municipalities with organized systems are either not treated or are only chlorinated. They are either soft, and high in alkali salts, or very hard.

The population served by organized supply in this basin is small (7·7 per cent of total basin population in 1951) and 54 per cent of these use very hard waters; the weighted hardness of such waters is high even in Alberta where the semi-arid nature of the terrain is not so pronounced.

SUMMARY

The Mississippi River basin in Canada comprises a small area of southern Alberta and Saskatchewan, semi-arid in many locations and including several closed drainage basins or watersheds. This area is somewhat similar to several larger areas in the United States and despite the rivers, lakes and creeks in the basin, water quality and supply are generally unsatisfactory for industrial use and development.

The terrain of the basin with its semi-arid regions results in waters relatively high in non-carbonate hardness and in sodium salts, particularly sodium sulphate. Several lakes and sloughs especially in the local drainage areas show, because of high evaporation and low inflow, such high mineralization especially in sodium sulphate, that they are an economic source of this salt.

Water quality in the basin differs markedly from that found in more fertile areas with higher rainfall. The former shows lower silica and higher fluoride contents and lower carbonate to sulphate ratios. In more fertile areas where rainfall results in considerable vegetation, the waters have a high content of carbon dioxide which causes leaching of carbonate salts from the soil. In the semi-arid areas, with little vegetation present, there is less evidence of carbonates and a greater leaching of sulphates from the soil.

Future development of this basin, even of the more fertile sections, appears largely dependent upon obtaining suitable water supplies. Much can no doubt be done by irrigation, retention of run-off and possibly by diversion of mountain waters into the basin. However, it is doubtful if in many sections of the basin major industrial expansion or indeed any appreciable industrial development can be expected unless other resources such as oil are found. Even if such occurs, water resources will remain of vital importance. It is imperative, therefore, that continued attention be paid to the efficient use and conservation of the waters now available within the basin.

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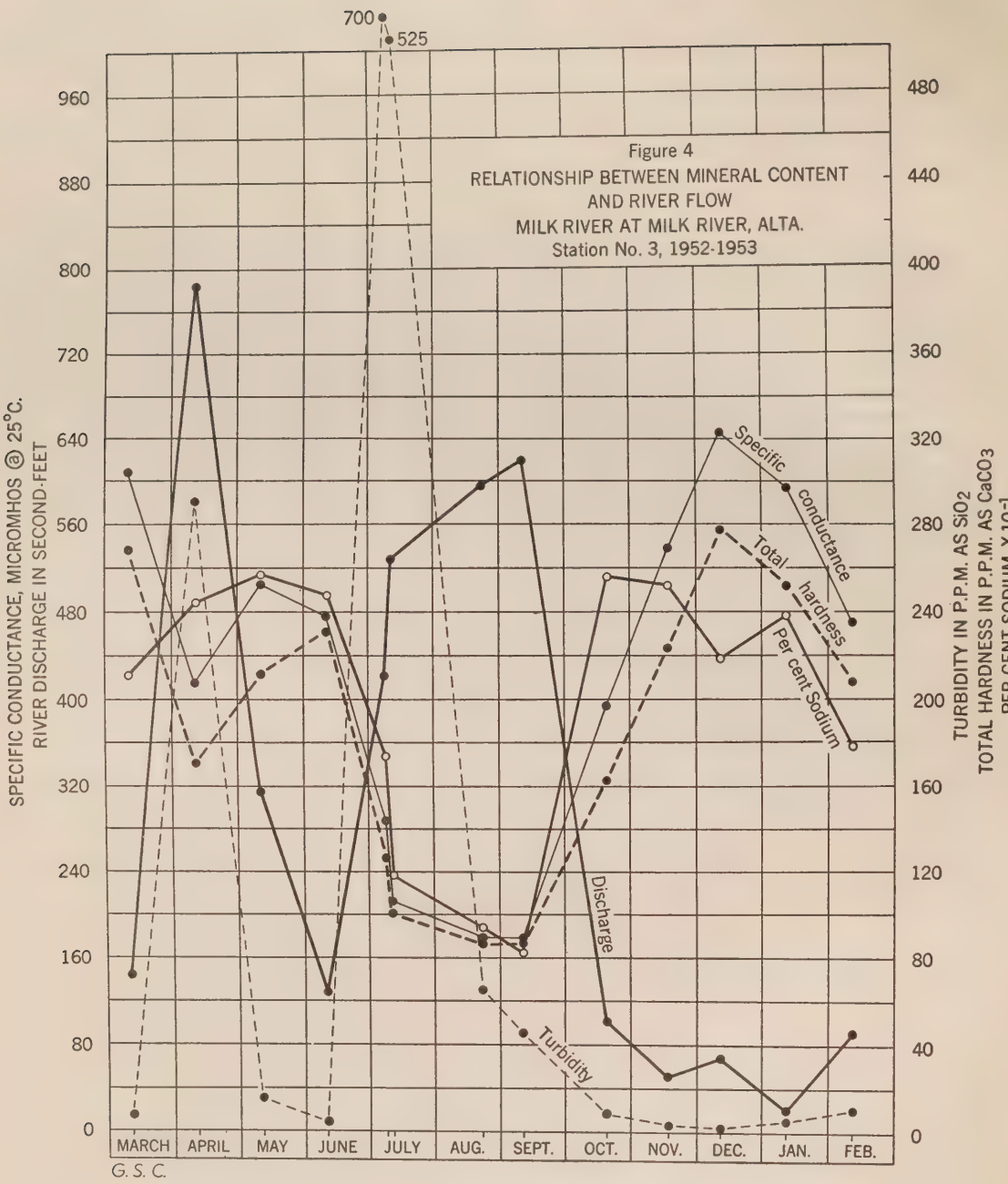
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Figure 4
RELATIONSHIP BETWEEN MINERAL CONTENT
AND RIVER FLOW
MILK RIVER AT MILK RIVER, ALTA.
Station No. 3, 1952-1953
SPECIFIC CONDUCTANCE, MICROMHOS @ 25°C.
RIVER DISCHARGE IN SECOND-FEET
TURBIDITY IN P.P.M. AS SiO2
TOTAL HARDNESS IN P.P.M. AS CaCO3
PER CENT SODIUM X 10-1
Specific conductance
Total hardness
Per cent Sodium
Discharge
Turbidity
MARCH
APRIL
MAY
JUNE
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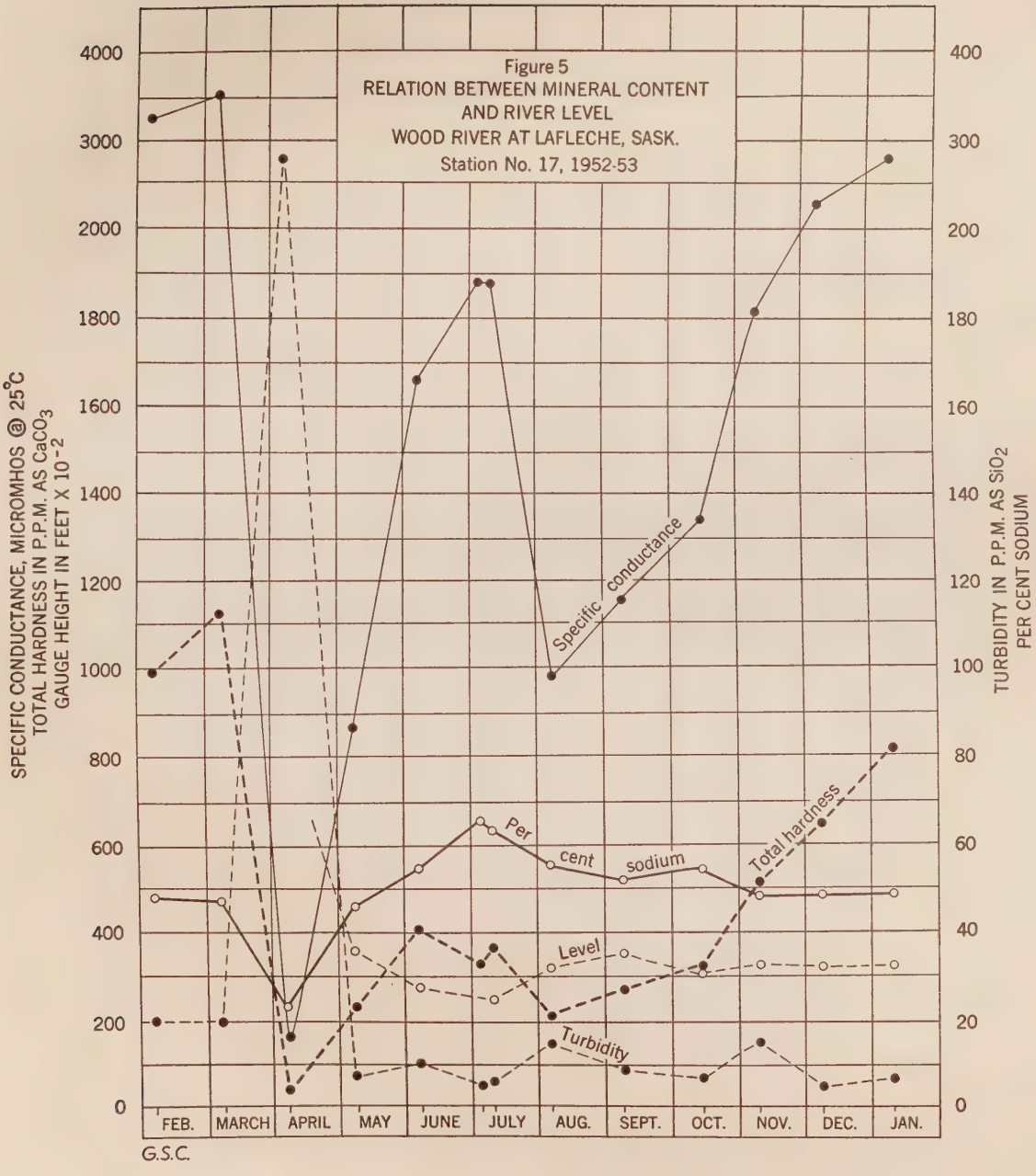
Figure 5
RELATION BETWEEN MINERAL CONTENT
AND RIVER LEVEL
WOOD RIVER AT LAFLECHE, SASK.
Station No. 17, 1952-53
SPECIFIC CONDUCTANCE, MICROMHOS @ 25°C
TOTAL HARDNESS IN P.P.M. AS $CaCO_3$
GAUGE HEIGHT IN FEET X 10^{-2}
TURBIDITY IN P.P.M. AS SiO_2
PER CENT SODIUM
Specific conductance
Per cent sodium
Total hardness
Level
Turbidity
4000
3000
2000
1800
1600
1400
1200
1000
800
600
400
200
0
400
300
200
180
160
140
120
100
80
60
40
20
0
FEB.
MARCH
APRIL
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JUNE
JULY
AUG.
SEPT.
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JAN.
G.S.C.

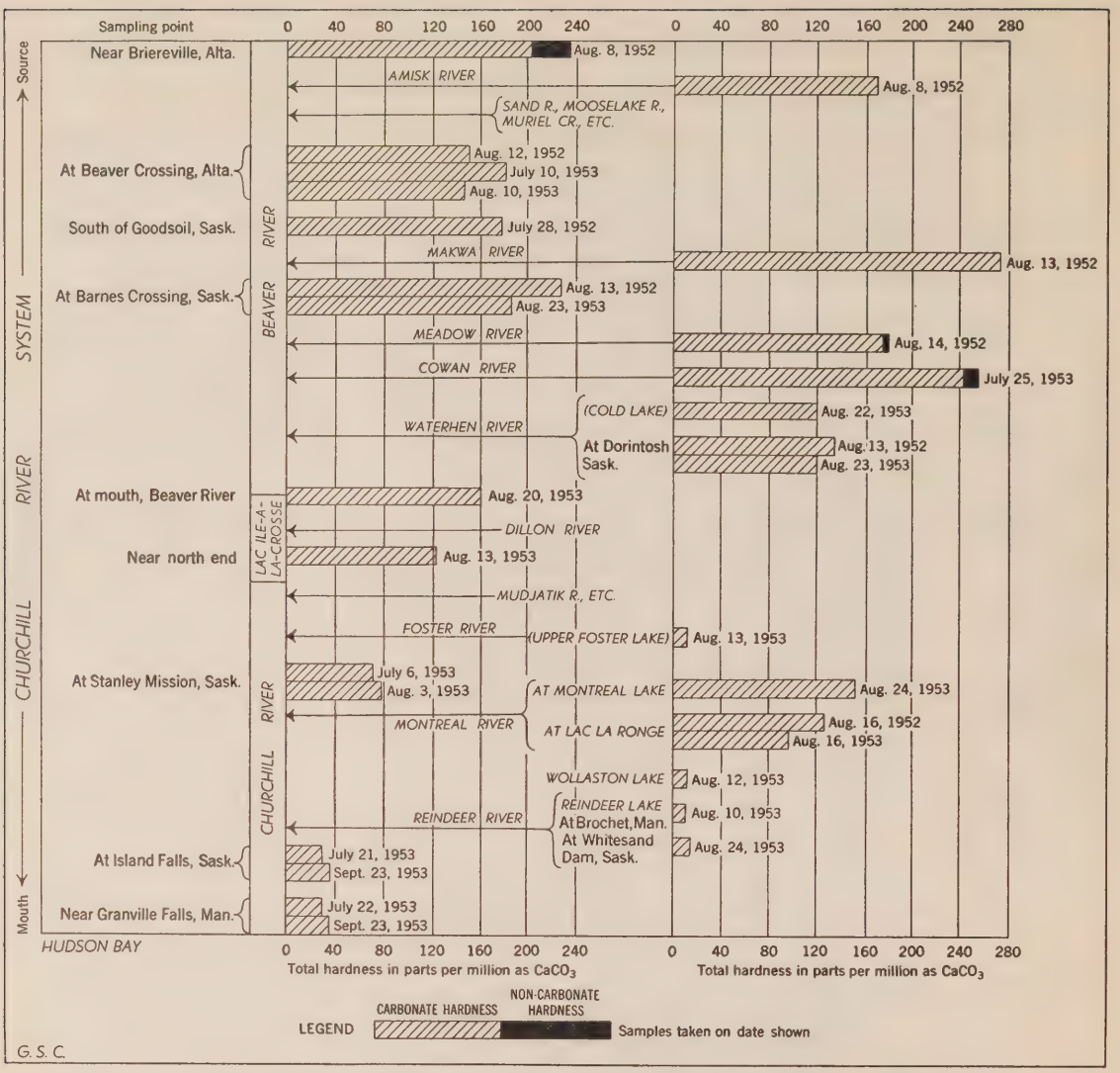


FIGURE 6. CHART SHOWING CHANGE IN WATER HARDNESS ALONG CHURCHILL RIVER SYSTEM

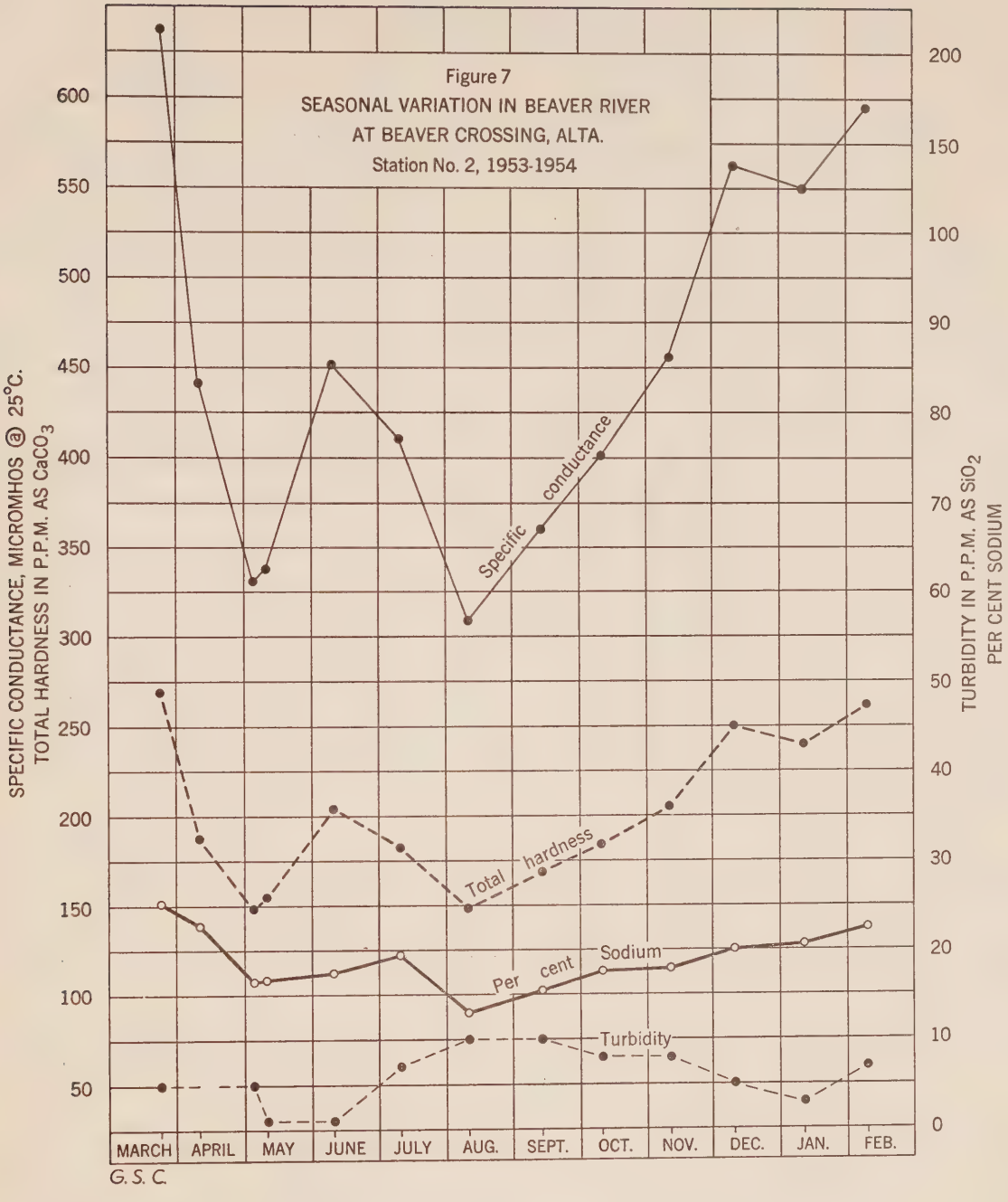


Figure 7
SEASONAL VARIATION IN BEAVER RIVER
AT BEAVER CROSSING, ALTA.
Station No. 2, 1953-1954
SPECIFIC CONDUCTANCE, MICROMHOS @ 25°C.
TOTAL HARDNESS IN P.P.M. AS $CaCO_3$
TURBIDITY IN P.P.M. AS SiO_2
PER CENT SODIUM
Specific conductance
Total hardness
Per cent Sodium
Turbidity
600
550
500
450
400
350
300
250
200
150
100
50
200
150
100
90
80
70
60
50
40
30
20
10
0
MARCH
APRIL
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
JAN.
FEB.
G. S. C.

TABLE II

Chemical Analyses of Surface Waters in the Mississippi River Drainage Basin in Canada

(In parts per million)

No.	Date of collection	Storage period (Days)	Stream discharge (Second-feet): On sampling date	Stream discharge (Second-feet): Monthly mean	Water temperature (°F.)	pH	Colour	Turbidity	Suspended matter: Dried at 105°C.	Suspended matter: Ignited at 550°C.	Specific conductance K x 10⁶ at 25°C.	Residue on evaporation dried at 105°C. (Dissolved solids): P.P.M.	Residue on evaporation dried at 105°C. (Dissolved solids): Tons per acre-foot	Residue on evaporation dried at 105°C. (Dissolved solids): Tons per day	Loss on ignition at 550°C.	Calcium (Ca)
STATION NO. 1—MILK RIVER, NORTH BRANCH near																
1	Aug. 15/51	6:20‡	630†	648†	64	8·0 (8·7)	12 (15)	45 (20)	56	42	180	100	0·136	169·5	32·0	23·3
2	Feb. 10/52	10:10	(3·01)*	.....	39	8·1	5	5	14·0	12·6	484	278	0·378	.....	54·2	55·9
3	Mar. 10	9:9	45 (1·86)	92·8	37	8·1	5	7	.....	.....	484	.....	.....	.....	.....	57·3
4	April 10	11:14	106 (2·05)	160	34	7·9	10	70	144	131	428	252	0·343	71·9	58·2	47·4
5	May 10	6:20	60 (1·81)	60·7	47	8·4	10	3	.....	.....	460	.....	.....	.....	.....	54·9
6	June 10	7:8	40·2 (1·64)	43·4	58	8·5	10	6	5·9	2·9	444	258	0·351	27·9	42·2	52·4
7	July 8	15:16	529	492	66	7·8 (8·2)	20 (—)	145 (—)	281	254	171 (177)	110	0·149	156·1	20·8	21·2
8	July 10	6:12	558 (3·45)	492	62	8·0	10	55	.....	.....	166	.....	.....	.....	.....	20·7
9	Aug. 11	8:10	602 (3·50)	589	57	7·9	5	15	30	29	157	88·4	0·120	145·7	20·2	20·2
10	Sept. 9	8:14	587 (3·49)	578	53	8·0	5	15	.....	.....	159	.....	.....	.....	.....	20·2
11	Oct. 10	10:18	291 (3·27)	173	53	7·9	10	10	.....	.....	173	.....	.....	.....	.....	23·3
12	Nov. 10	7:18	...(1·50)	No records	57	8·1	5	1	.....	.....	435	248	0·337	.....	82·8	49·0
13	Dec. 11	6:43	...(1·97)		33	8·4	10	3	.....	.....	474	.....	.....	.....	.....	56·0
14	Jan. 12/53	11:31	...(2·58)		32	8·0	90	15	10·4	7·4	394	245	0·333	.....	49·6	42·1

† Records at International Boundary—2½ miles east of Whisky Gap.

‡ Ice conditions—March 1 to April 8, April 15 to April 24, 1952.

*Values in brackets are gauge level readings supplied by the collector.

STATION NO. 2—MILK RIVER at highway																
15	Aug. 15/51	6:24	798†	777†	68	8·5 (8·7)	5 (20)	10 (5)	.....	.....	425 (425)	.....	.....	.....	.....	46·0
16	July 8/52	15:21	421†	494†	75	8·2 (8·7)	10 (15)	4 (5)	.....	.....	425 (430)	.....	.....	.....	.....	34·7

Dissolved oxygen, July 8, 1952—8·0 p.p.m. (field test).

† Records at Milk River, Alta.

STATION NO. 3—MILK RIVER at MILK RIVER,																
17	Aug. 15/51	6:20	798	777	67	7·9 (8·6)	5 (20)	100 (—)	192	178	246 (235)	149	0·203	320·0	47·0	31·7
18	Mar. 11/52	8:8	143	427	32	8·0	5	7	9·3	7·5	608	369	0·502	142·0	63·6	58·5
19	April 12	9:12	783	967	40	7·7	15	290	632	588	414	260	0·354	547·3	70·0	37·4
20	May 11	10:19	313	323	67	8·5	10	15	.....	.....	504	.....	.....	.....	.....	48·8
21	June 11	6:7	124	162	65	8·7	5	4	7·5	4·5	476	288	0·392	96·1	47·4	41·3

TABLE II

Chemical Analyses of Surface Waters in the Mississippi River Drainage Basin in Canada

(In parts per million)

Magnesium (Mg)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)	Iron (Fe): Dissolved	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Silica (SiO_2): Colorimetric	Hardness as $CaCO_3$: Non-carbonate	Hardness as $CaCO_3$: Total	Sum of constituents	Per cent sodium	Saturation index	Stability index	No.
WHISKY GAP, ALTA.—Drainage area, 101 square miles.																		
8·5	2·9	0·6	0·06	3·8	1·0	3·0	0·25	.....	111 (92·7)	0 (6·0)	5·0	2·3 (4·8)	93·1 (90·8)	103	6·7	−0·1	8·2	1
24·0	11·0	2·0	0·04	9·4	3·0	6·4	0·20	.....	295	7·2	11	0·0	238	275	9·0	+0·8	6·5	2
25·0	12·3	1·1	.....	9·5	1·0	6·0	.....	.....	310	1·2	12	0·0	246	278	9·8	+0·8	6·5	3
21·5	11·5	3·0	0·04	11·0	3·0	5·0	0·20	.....	264	0	13	0·0	207	245	10·7	+0·4	7·1	4
21·9	16·4	1·0	.....	7·8	2·0	1·6	.....	.....	298	4·8	9·5	0·0	227	267	13·5	+1·0	6·4	5
24·0	11·6	1·4	0·08	6·3	0·9	2·0	0·05	.....	289	9·6	12	0·0	253	263	9·8	+1·2	6·1	6
7·8	2·1	0·6	0·10	5·4	0·7	0·8	.....	.....	101 (100)	0 (0)	5·4	1·9 (1·5)	84·9 (83·5)	94·0	5·1	−0·4	8·6	7
7·3	2·1	0·4	.....	4·7	0·4	0·3	.....	.....	98·6	0	7·8	0·9	81·7	92·3	5·3	−0·1	8·2	8
6·6	2·0	0·2	0·04	6·3	1·6	0·1	0·10	.....	90·4	1·4	3·9	0·9	77·5	87·1	5·3	−0·3	8·5	9
6·4	1·5	0·5	.....	7·4	0·1	0·2	.....	.....	89·1	0	3·2	3·4	76·7	83·4	4·0	−0·3	8·6	10
7·3	2·0	0·5	.....	6·2	1·2	0·3	.....	.....	105	0	3·8	1·9	88·1	96·4	4·7	−0·3	8·5	11
23·0	10·0	0·7	0·04	9·0	1·5	0·3	.....	.....	272	8·4	9·7	0·0	217	246	9·1	+0·9	6·3	12
24·2	10·5	1·3	.....	9·2	1·1	4·0	.....	.....	300	8·4	11	0·0	239	274	8·7	+1·1	6·2	13
18·7	12·8	4·3	0·09	12·5	2·7	3·0	.....	0·06	243	0	12	0·0	182	228	12·9	+0·4	7·2	14
bridge, west of MILK RIVER, ALTA.																		
21·0	21·0	1·2	.....	22·3	2·2 (2·4)	0·3	0·00	.....	253	7·2	3·1	0·0 (0)	201 (204)	250	18·3	+1·0	6·5	15
22·6	24·0	0·8	.....	32·9	2·6	0·3	.....	.....	226	9·6	3·2	0·0 (0)	181 (181)	242	22·5	+0·6	7·0	16
ALTA.—Drainage area, 1,104 square miles.																		
11·2	8·3	1·2	0·09	9·9	0·6 (0·6)	3·4	0·30	.....	156 (133)	0 (9·1)	8·2	0·0 (0)	124 (121)	152	12·5	−0·02	7·9	17
29·6	33·5	3·2	0·02	47·3	2·8	4·0	0·30	.....	354	0	13	0·0	268	366	21·1	+0·7	6·6	18
18·5	26·1	5·1	0·06	38·3	3·7	2·0	.....	.....	225	0	12	0·0	169	254	24·4	+0·1	7·5	19
22·0	34·0	2·1	.....	28·5	3·9	.....	.....	.....	279	11	6·4	0·0	212	304	25·6	+1·1	6·3	20
24·1	31·0	2·4	0·07	35·2	2·4	.....	0·05	0·07	253	14·4	6·2	0·0	231	282	24·7	+1·3	6·1	21

TABLE II—Continued

Chemical Analyses of Surface Waters of the Mississippi River Drainage Basin in Canada

(In parts per million)

No.	Date of collection	Storage period (Days)	Stream discharge (Second-feet) On sampling date	Stream discharge (Second-feet) Monthly mean	Water temperature (°F.)	pH	Colour	Turbidity	Suspended matter Dried at 105°C.	Suspended matter Ignited at 550°C.	Specific conductance K x 10^6 at 25°C.	Residue on evaporation dried at 105°C. (Dissolved solids) P.P.M.	Residue on evaporation dried at 105°C. (Dissolved solids) Tons per acre-foot	Residue on evaporation dried at 105°C. (Dissolved solids) Tons per day	Loss on ignition at 550°C.	Calcium (Ca)
	STATION NO. 3—MILK RIVER at MILK RIVER,															
1	July 8	15:16	421	494	69	7·6 (8·2)	20 (—)	700 (0)	854	794	289 (280)	178	0·242	202	35·4	28·2
2	July 11	11:18	524	494	61	7·9	20	525	.....	.....	212	.....	.....	.....	.....	23·5
3	Aug. 22	7:14	595	608	69	8·1	10	65	.....	157	178	105	0·142	175·4	33·8	27·6
4	Sept. 11	6:12	619	611	56	8·2	10	45	.....	.....	178	.....	.....	.....	.....	22·0
5	Oct. 19	12:26	101	231	52	8·1	3	8	.....	.....	393	.....	.....	.....	.....	37·1
6	Nov. 17	8:23	51	56·5	34	8·2	5	3	.....	.....	537	323	0·439	44·3	49·2	49·1
7	Dec. 11	6:43	68	57	32	8·4	8	2	.....	.....	646	.....	.....	.....	.....	63·5
8	Jan. 11/53	9:26	20	60	34	8·0	10	5	.....	.....	594	.....	.....	.....	.....	57·5
9	Feb. 11	12:17	90	77	33	8·1	30	10	7·2	4·6	470	282	0·384	68·3	53·0	48·0
	STATION NO. 4—LODGE CREEK, south of															
10	July 7/52	16:17	0·1†	0·65†	63	7·8 (8·1)	30 (50)	7 (10)	20	16	914 (920)	643	0·874	0·02	84·6	73·8
	† Records near Alberta boundary.															
	STATION NO. 5—BATTLE CREEK, near CONSUL, SASK.															
11	Aug. 11/51	6:11	2·4†	8·5†	71	8·5 (9·1)	10 (7)	8 (10)	12·5	9·2	839	594	0·808	3·8	132	43·2
12	Feb. 9/52	17:17	(6″ water 3′ ice)	32	32	7·9	3	5	4·0	2·4	809	538	0·73	.....	81·2	90·1
13	Mar. 10	9:9	6‡	8·42	32	7·9	5	3	.....	.....	731	.....	.....	.....	.....	81·3
14	April 9	12:14	636‡	690	32	7·2	40	4	.....	.....	122	.....	.....	.....	.....	13·1
15	May 13	16:16	93·0	95·9	59	8·4	15	7	.....	.....	559	.....	.....	.....	.....	62·6
16	June 10	7:8	29·4	25·0	69	8·6	10	4	4·9	3·2	639	412	0·547	32·6	65·4	59·7
17	July 7	16:17	15·5	16·9•	61	8·0 (8·2)	15 (35)	3 (<5)	.....	.....	670 (680)	447	0·608	18·6	77·2	44·9
18	July 11	12:18	13·7	16·9•	65	8·0	15	4	.....	.....	592	.....	.....	.....	.....	42·1
19	Aug. 14	15:22	13·0•	5·68•	62	8·1	10	0·6	.....	.....	755	520	0·707	18·2	96·8	46·0
20	Sept. 11	13:18	5·7	6·23	63	8·1	15	4	.....	.....	668	.....	.....	.....	.....	39·2
21	Oct. 11	15:34	8·3	8·66	43	8·2	8	8	.....	.....	700	.....	.....	.....	.....	53·1
22	Nov. 10	14:18	No		34	8·3	10	5	13	12	743	481	0·654	.....	77·2	64·8
23	Dec. 11	6:43	discharge		34	8·2	15	7	.....	.....	868	.....	.....	.....	.....	93·2
24	Jan. 11/53	14:55	records		32	8·1	15	9	16	12	833	524	0·713	.....	81·4	90·7

† Records above Cypress Lake, West Inflow Canal. ‡ Ice conditions—March 1 to April 13, 1952. • Estimated.

TABLE II—Continued

Chemical Analyses of Surface Waters in the Mississippi River Drainage Basin in Canada

(In parts per million)

Magnesium (Mg)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)	Iron (Fe): Dissolved	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Silica (SiO_2): Colorimetric	Hardness as $CaCO_3$: Non-carbonate	Hardness as $CaCO_3$: Total	Sum of constituents	Per cent sodium	Saturation index	Stability index	No.
ALTA.—Drainage area, 1,104 square miles.—*Concluded*																		
13·4	12·3	2·1	0·63	22·2	0·8	3·0	.....	.....	160 (156)	0 (0)	10	0·0 (0)	126 (120)	172	17·3	−0·2	8·0	1
10·2	6·3	1·1	.....	13·6	0·6	1·2	.....	.....	124	0	7·6	0·0	101	125	11·8	−0·1	8·1	2
4·1	4·1	0·6	0·06	7·7	0·6	0·4	0·00	.....	95·9	3·8	5·8	0·9	85·9	102	9·3	+0·1	7·9	3
7·7	3·6	0·4	.....	7·6	0·8	0·4	.....	.....	97·4	2·6	3·6	2·5	86·7	96·7	8·2	0	8·2	4
16·9	26·0	1·4	.....	43·4	1·9	0·6	.....	.....	205	4·1	5·8	0·0	162	238	25·6	+0·4	7·3	5
24·4	35·0	2·1	0·18	53·8	2·7	1·2	.....	.....	280	9·8	6·7	0·0	223	322	25·2	+0·8	6·6	6
28·9	36·0	1·6	.....	54·5	3·7	1·7	.....	.....	351	11	10	0·0	277	384	21·9	+1·2	6·0	7
26·2	36·5	2·1	.....	58·5	3·6	3·6	.....	.....	325	2·4	7·6	0·0	252	358	23·8	+0·7	6·6	8
21·4	21·0	2·5	0·04	31·4	2·4	2·0	0·10	.....	272	0	9·0	0·0	208	271	17·8	+0·7	6·7	9
GOVENLOCK, SASK.—Drainage area, 342 square miles.																		
33·5	76·0	10·0	0·45	264	8·1	0·7	0·40	.....	261 (268)	0 (0)	8·4	108 (117)	322 (327)	604	33·1	+0·5	6·8	10
—Drainage area near WEST PLAINS, SASK., 240 square miles.																		
41·5	76·5	10·9	.....	0·07	4·3 (4·7)	3·0	0·60	.....	228 (148)	17 (48)	5·0	62·4 (76·8)	279 (270)	553	36·2	+0·95	6·5	11
34·0	43·0	4·1	0·01	88·7	3·7	0·0	0·40	.....	436	0	11	7·4	365	501	20·4	+0·7	6·5	12
32·0	34·0	3·2	.....	81·0	2·7	0·4	.....	.....	395	0	21	10·4	334	451	17·9	+0·8	6·3	13
3·9	2·5	4·5	.....	7·4	2·3	0·0	.....	.....	61·0	0	3·4	0·0	48·7	67·1	9·1	−1·4	10·0	14
21·7	28·0	3·3	.....	59·1	2·8	trace	.....	.....	288	9·1	15	0·0	246	343	19·6	+1·1	6·2	15
31·0	37·0	4·2	0·10	95·3	3·7	0·0	0·10	0·06	304	9·4	12	12·0	277	402	22·2	+1·4	5·8	16
33·1	53·0	5·8	0·35	137	3·6	0·6	0·40	.....	266 (273)	4·8 (3·8)	6·9	22·4 (23·0)	421 (253)	421	31·1	+0·6	6·8	17
31·0	41·0	4·8	.....	102	8·9	0·6	.....	.....	255	4·3	8·8	16·8	233	369	27·2	+0·5	7·0	18
37·4	64·5	5·4	0·10	173	5·1	0·6	0·30	.....	274	3·6	6·6	38·2	269	478	33·7	+0·7	6·7	19
31·4	55·0	6·2	.....	137	4·0	trace	.....	.....	237	9·8	4·2	16·4	227	403	33·7	+0·5	7·1	20
32·5	55·0	4·8	.....	129	4·3	0·5	.....	.....	292	9·1	6·9	12·3	267	439	30·5	+0·8	6·6	21
33·9	53·0	4·4	0·02	121	4·4	0·2	.....	.....	335	12	12	6·9	301	470	27·3	+1·0	6·3	22
37·0	49·3	4·2	.....	106	4·2	0·6	.....	.....	476	0	19	0·0	385	547	21·6	+1·1	6·0	23
35·0	45·9	4·0	0·03	100	3·6	0·6	0·20	0·01	456	0	16	0·0	370	522	21·4	+1·1	5·9	24

78878—4

TABLE II—Continued

Chemical Analyses of Surface Waters in the Mississippi River Drainage Basin in Canada

(In parts per million)

No.	Date of collection	Storage period (Days)	Stream discharge (Second-feet): On sampling date	Stream discharge (Second-feet): Monthly mean	Water temperature (°F.)	pH	Colour	Turbidity	Suspended matter: Dried at 105°C.	Suspended matter: Ignited at 550°C.	Specific conductance K x 10⁶ at 25°C.	Residue on evaporation dried at 105°C. (Dissolved solids): P.P.M.	Residue on evaporation dried at 105°C. (Dissolved solids): Tons per acre-foot	Residue on evaporation dried at 105°C. (Dissolved solids): Tons per day	Loss on ignition at 550°C.	Calcium (Ca)
STATION NO. 6—CYPRESS																
1	July 7/52	15:23	16·4	15·6	61	8·2 (8·2)	20 (30)	7† (—)	6·7	3·2	759 (770)	527	0·717	.....	92·6	45·8
† Algae or grass in considerable quantity in lake.																
STATION NO. 7—FRENCHMAN																
2	Aug. 11/51	6:28	2·1†	22·4†	59	8·1 (8·3)	5 (35)	15 (10)	.....	.....	746 (730)	.....	.....	.....	.....	58·0
3	Feb. 9/52	11:11	(4′)	.....	32	7·5	5	9	9·0	8·3	489	299	0·407	.....	36·8	57·2
4	Mar. 7	12:12	22(4′)‡	25·2	32	7·8	10	4	.....	.....	511	.....	.....	.....	.....	58·2
5	April 7	14:16	(12′)‡	1,451	34	7·2	25	210	.....	.....	157	.....	.....	.....	.....	24·3
6	May 9	12:21	146(8′)	110	40	8·2	10	40	.....	.....	612	.....	.....	.....	.....	62·6
7	June 7	6:11	54·0 (5′10″)	60·9	65	8·4	15	10	15	11	679	453	0·616	.....	53·4	60·5
8	July 6	16:18	37·4(—)	37·1	65	8·1 (8·3)	20 (50)	10 (15)	32	27	842 (870)	587	0·798	59·1	82·0	69·7
9	July 7	9:15	36·2(6′)	37·1	44	8·1	20	10	.....	.....	857	.....	.....	.....	.....	70·5
10	Aug. 8	12:17	18·1(4′)	16·6	48	8·1	20	15	31	27	745	505	0·687	24·6	121	62·5
11	Sept. 8	9:15	21·1(5′)	18·8	57	8·1	15	75	.....	.....	492	.....	.....	.....	.....	43·4
12	Oct. 7	9:13	14·0(3½′)	14·1*	38	8·2	10	8	.....	.....	665	.....	.....	.....	.....	60·8
13	Nov.	No sample taken			.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
14	Dec. 7	10:59	.. (4′8″)	.....	33	8·2	20	30	30	27	750	483	0·657	.....	71·2	76·8
15	Jan. 7/53	9:34	.. (4′)	.....	33	8·0	15	15	.....	.....	675	.....	.....	.....	.....	70·8
† Records below East End reservoir. ‡ Ice conditions—March 1st to April 12th, 1952. * Estimated.																
STATION NO. 8—FRENCHMAN																
16	Aug. 10/51	7:12	.....	.....	68	8·4 (8·7)	5 (35)	25 (20)	35	30	8·8	575	0·782	.....	118	47·6
17	Feb. 7/52	26:76	No discharge record		34	7·7	30	15	17	14	1,204	848	1·153	.....	126	83·3
18	Mar. 10	9:9			33	8·0	20	7	.....	.....	968	.....	.....	.....	.....	79·6
19	April 8*	13:35			35	7·2	30	150	.....	.....	299	.....	.....	.....	.....	21·3
20	May	No sample taken		20·9†	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
21	June			59·6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
22	July 5	9:18	83	147	72	8·1 (8·7)	10 (20)	3 (5)	.....	.....	1,026 (1,080)	733	0·997	16·4	111	64·1
* Flood water sample.																

TABLE II—Continued

Chemical Analyses of Surface Waters in the Mississippi River Drainage Basin in Canada

(In parts per million)

Magnesium (Mg)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)	Iron (Fe): Dissolved	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Silica (SiO_2): Colorimetric	Hardness as $CaCO_3$: Non-carbonate	Hardness as $CaCO_3$: Total	Sum of constituents	Per cent sodium	Saturation index	Stability index	No.
LAKE at dam in SASK.																		
37·7	51·2	12·4	0·06	206	4·2	2·0	0·60	.....	222 (220)	3·6 (7·6)	19	81·3 (81·3)	269 (273)	494	28·1	+0·2	7·8	1
RIVER near EAST END, SASK.																		
38·5	54·0	5·2 (2·4)	.....	153	2·5	0·1	0·40	.....	305 (298)	9·6 (4·8)	2·6	37·0 (55·6)	303 (308)	474	27·5	+0·8	6·5	2
23·0	17·5	2·6	0·02	42·7	3·2	0·5	0·10	.....	283	0	14	5·3	237	300	13·7	+0·2	7·1	3
23·0	19·4	2·2	.....	47·3	1·3	1·2	.....	.....	283	0	15	7·8	240	307	14·8	+0·4	7·0	4
5·4	4·3	4·5	.....	14·8	2·2	0·1	.....	.....	75·6	0	3·6	2·9	64·9	96·3	11·7	−1·0	9·2	5
29·3	28·0	3·4	.....	101	5·2	trace	.....	.....	275	5·5	13	42·0	277	383	17·8	+0·9	6·4	6
32·6	44·5	5·5	0·09	131	3·1	.....	0·20	0·08	277	4·1	12	51·2	285	430	24·9	+1·0	6·4	7
42·0	56·0	7·2	0·04	189	4·0	1·0	0·50	.....	325 (341)	6·0 (3·2)	14 (11)	70·5 (68·0)	347 (351)	550	25·5	+1·0	6·1	8
41·8	60·0	6·8	.....	195	4·0	0·1	.....	.....	339	2·4	12	65·6	348	559	26·8	+1·0	6·1	9
37·4	47·0	5·0	0·04	154	3·7	1·0	0·25	.....	293	6·0	11	60·3	310	472	24·4	+0·8	6·5	10
23·8	23·0	3·6	.....	85·0	2·3	0·5	.....	.....	208	2·2	7·5	32·3	206	294	19·1	+0·5	7·1	11
34·3	34·0	4·2	.....	118	4·8	0·1	.....	.....	301	4·3	10	39·0	293	419	19·9	+0·9	6·4	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
36·2	35·0	3·6	0·03	108	3·3	1·1	0·38	.....	380	2·9	14	24·2	341	468	18·1	+1·0	6·2	14
32·0	30·0	3·0	.....	89·7	2·5	0·4	.....	.....	352	0	15	19·8	309	417	17·3	+0·7	6·6	15
RIVER near VAL MARIE, SASK.																		
36·7	76·5	7·3	0·11	242	4·7 (4·0)	3·6	0·50	.....	215 (191)	8·2 (16)	6·2	79·7 (79·2)	270 (263)	539	37·3	+0·8	6·8	16
57·5	100	8·8	0·03	314	8·4	1·4	.....	.....	436	0	12	87·3	444	800	32·3	+0·6	6·5	17
46·3	74·5	5·8	.....	204	5·5	1·6	.....	.....	414	0	17	49·4	389	638	28·7	−0·02	8·0	18
10·3	19·5	6·3	.....	53·9	3·0	3·6	.....	.....	107	0	6·5	7·5	95·5	177	29·0	−1·0	9·2	19
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
47·3	92·0	7·4	0·16	324	6·4	0·3	0·40	.....	253 (242)	8·9 (14)	7·8	132 (139)	355 (361)	684	35·4	+0·9	6·3	22

† May 10th to 31st inclusive.

TABLE II—Continued

Chemical Analyses of Surface Waters in the Mississippi River Drainage Basin in Canada

(In parts per million)

No.	Date of collection	Storage period (Days)	Stream discharge (Second-feet): On sampling date	Stream discharge (Second-feet): Monthly mean	Water temperature (°F.)	pH	Colour	Turbidity	Suspended matter: Dried at 105°C.	Suspended matter: Ignited at 550°C.	Specific conductance K x 10⁶ at 25°C.	Residue on Evaporation dried at 105°C. (Dissolved solids): P.P.M.	Residue on Evaporation dried at 105°C. (Dissolved solids): Tons per acre-foot	Residue on Evaporation dried at 105°C. (Dissolved solids): Tons per day	Loss on ignition at 550°C.	Calcium (Ca)
	STATION NO. 9—WEST BRANCH POPLAR RIVER near															
1	July 2/52	7:9	0·1	5·82	66	8·7 (9·1)	40 (7·5)	2 (5)	.....	.....	1,128 (1,210)	784	1·07	0·21	86·2	16·6
	Dissolved oxygen (field test)—8·4 p.p.m.															
	STATION NO. 10—MIDDLE BRANCH POPLAR RIVER, south of ROCKGLEN,															
2	April 22/52	11:16	77† (6′2″)‡	6·99†	44	7·9	30	5	4·4	1·6	335	228	0·310	47·2	50·8	34·7
2	May 15	6:15	9·8 (5′6″)	10·7	48	8·6	20	6	.....	.....	978	.....	.....	.....	.....	50·8
3	June 17	7:8	0·8•(4′11″)	3·31	52	8·6	5	0·6	.....	.....	712	452	0·615	0·97	103	27·6
4	July 2*	7:15	5·3 (—)	14·9	67	8·4 (...)	15 (25)	4 (<5)	14·4	7·4	691	433	0·589	6·2	114	32·0
5	July 14	8:15	2·1 (4′10″)	14·9	68	8·4	15	0·2	.....	.....	701	.....	.....	.....	.....	29·5
6	Aug. 17	8:19	0·5 (5′1″)	1·10	68	8·4	10	1	.....	.....	780	520	0·707	0·70	120	28·3
7	Sept. 15	7:8	2·4 (4′11″)	2·42	55	8·2	20	2	.....	.....	706	.....	.....	.....	.....	36·7
8	Oct. 15	6:30	2·7 (5′1″)	2·47	35	8·2	5	0·5	.....	.....	742	.....	.....	.....	.....	46·2
9	Nov. 14	10:14	... (4′10″)	.....	33	8·3	10	0·5	.....	.....	771	479	0·651	.....	117	50·9
10	Dec. 15	7:39	... (5′4″)	.....	35	8·1	15	3	.....	.....	1,033	.....	.....	.....	.....	80·4
11	Apr. 9/53	7:44	41·6 (7′2″)	44·2	32	8·0	90	5	.....	.....	334	.....	.....	.....	.....	28·0
12	May 13	9:30	47·8 (7′11″)	53·6	46	8·6	60	2	.....	.....	1,028	732	0·996	94·1	164	55·2

† Records at gauge ¼ miles south of International Boundary.
‡ Values in brackets are gauge levels supplied by collector.
* Sample may have lost some calcium carbonate in storage.
• Estimated.

	STATION NO. 11—FIFE LAKE, south															
13	July 2/52	7:9	.....	.....	64	8·8 (9·1)	..... (25)	50 (50)	62	49	2,378	1,664	2·26	.....	203	11·2
	STATION NO. 12—EAST BRANCH POPLAR															
14	July 2/52	7:9	6·6†	5·36†	65	7·9 (7·9)	20 (40)	2 (<5)	.....	.....	1,042 (1,080)	698	0·949	12·4	117	55·4

† Records near International Boundary, drainage area, 256 square miles.
Dissolved oxygen (field test)—8·4 p.p.m.
Carbon dioxide (field test)—8·5 p.p.m.

	STATION NO. 13—ETZIKOM															
15	July 7/52	16:17	.....	.....	66	8·6 (8·9)	80 (120)	3 (5)	.....	.....	1,808 (1,800)	1,327	1·805	.....	178	46·9

TABLE II—Continued

Chemical Analyses of Surface Waters in the Mississippi River Drainage Basin in Canada

(In parts per million)

Magnesium (Mg)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)	Iron (Fe): Dissolved	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Silica (SiO_2): Colorimetric	Hardness as $CaCO_3$: Non-carbonate	Hardness as $CaCO_3$: Total	Sum of constituents	Per cent sodium	Saturation index	Stability index	No.
INTERNATIONAL BOUNDARY, SASK.—Drainage area, about 141 square miles.																		
22·9	224	9·2	0·45	165	6·0	0·6	0·60	.....	458 (473)	49 (46)	21 (2·8)	0·0 (0)	136 (140)	722	76·8	+1·1	6·5	1
SASK.—Drainage area, ¾ mile south of International Boundary, 381 square miles.																		
18·0	11·3	5·4	0·06	15·6	1·4	0·4	.....	.....	212	0	13	0·0	161	205	12·8	+0·2	7·5	2
51·8	112	7·4	.....	107	4·6	trace	.....	.....	515	31	9·5	0·0	340	628	41·1	+1·5	5·6	2
48·5	62·5	6·8	0·17	77·8	1·3	trace	0·40	0·40	358	18	2·4	0·0	268	422	32·9	+1·1	6·4	3
45·7	55·0	6·9	0·05	78·9	2·7	0·3	0·30	.....	327 (371)	25* (9·6)	5·2	0·0 (0)	268 (283)	438	30·2	+1·0	6·4	4
47·2	58·0	7·6	.....	82·3	3·3	trace	.....	.....	362	14	4·8	0·0	268	426	31·2	+1·0	6·4	5
45·1	79·0	7·7	0·05	85·7	2·7	trace	0·30	.....	395	19	6·0	0·0	256	469	39·2	+0·9	6·6	6
45·2	55·5	6·8	.....	72·8	3·3	0·4	.....	.....	379	12	8·1	0·0	278	427	29·7	+0·7	6·8	7
46·3	52·0	6·0	.....	76·7	2·5	trace	.....	.....	393	17	7·8	0·0	306	448	26·5	+0·8	6·6	8
46·6	54·0	7·2	0·05	80·5	3·0	0·3	.....	.....	427	7·7	11	0·0	319	471	26·4	+1·0	6·3	9
59·3	70·4	7·4	.....	105	3·7	0·5	.....	.....	622	0	14	0·0	445	647	25·2	+0·2	7·7	10
18·0	13·0	7·4	.....	31·7	1·9	1·4	.....	.....	175	0	9·0	0·5	144	197	15·6	+0·1	7·8	11
53·8	115	9·5	0·18	153	4·0	0·4	0·20	.....	530	11	17	0·0	359	680	40·3	+1·4	5·8	12
shore, near CONSTANCE, SASK.																		
78·8	450	40·5	0·14	608	17·5	1·6	.....	.....	660 (622)	108 (120)	1·1	0·0 (0)	352 (359)	1,642	70·7	+1·2	6·4	13
RIVER near CORONACH, SASK.																		
45·5	121	8·2	0·47	173	5·1	0·6	0·40	.....	450 (489)	19 (0)	4·2 (4·2)	0·0 (0)	326 (331)	655	43·9	+0·8	6·3	14
COULEE near ETZIKOM, ALTA.																		
51·5	300	22·5	0·26	562	36·1	2·4	0·80	.....	368 (343)	32 (49)	5·4 (3·6)	0·0 (0)	329 (333)	1,242	64·6	+1·3	6·0	15

TABLE II—Continued

Chemical Analyses of Surface Waters in the Mississippi River Drainage Basin in Canada

(In parts per million)

No.	Date of collection	Storage period (Days)	Stream discharge (Second-feet): On sampling date	Stream discharge (Second-feet): Monthly mean	Water temperature (°F.)	pH	Colour	Turbidity	Suspended matter: Dried at 105°C.	Suspended matter: Ignited at 550°C.	Specific conductance K x 10⁶ at 25°C.	Residue on evaporation dried at 105°C. (Dissolved solids): P.P.M.	Residue on evaporation dried at 105°C. (Dissolved solids): Tons per acre-foot	Residue on evaporation dried at 105°C. (Dissolved solids): Tons per day	Loss on ignition at 550°C.	Calcium (Ca)
																STATION NO. 14—
1	July 7/52	16:22			67	7·9 (8·5)	(—)	550[b] (—)			941 (990)					24·4
																STATION NO. 15 TWELVEMILE
2	July 3/52	7:20			74	8·6 (9·0)	(45)	80 (—)	148	120	1,373 (1,540)	906	1·23		83·0	13·6
																STATION NO. 16—WOOD
3	July 4/52	6:18			71	8·7 (9·1)	30 (50)	10 (10)			2,180					70·8†
																STATION NO. 17 WOOD RIVER at
4	Aug. 2/51	8:13			78	8·8 (8·8)	40 (55)	15 (25)	12·2	8·8	1,077 (1,065)	766	1·04		112	44·1
5	Feb. 7/52	No record but very little flow			32	7·4	25	20	23	15	3,250	2,685	3·65		208	192
6	Mar. 7	6:7			32	7·8	45	20			3,530					222
7	April 7	14:36		3,472	37	7·3	15	280			166					12·5
8	May 7	7:8	(3·61′)	36·0	55	7·9	30	7	6·1	1·6	873	617	0·839		62·6	53·8
9	June 7	6:11	(2·8′)	9·11	67	8·4	25	10			1,658					79·2
10[a]	July 4	6:19		No record	70	8·5 (9·3)	25 (50)	5 (10)	10·2	6·3	1,885	1,355	1·84		127	39·7
11	July 9	7:13	(2·5′)	"	73	8·2	30	6			1,880					51·2
12	Aug. 7	5:14	(3·2′)	"	71	7·8	70	15	20	16	983	682	0·928		115	41·3
13	Sept. 9	8:14	(3·52′)	"	68	8·1	40	9			1,152					55·7
14	Oct. 14	15:31	(3·02′)	"	43	8·2	30	7			1,344					63·0
15	Nov. 10	14:18	(3·27′)	"	37	8·2	25	15	62	54	1,814	1,356	1·84		215	103
16	Dec. 8	9:42	(3·21′)	"	34	8·1	35	5			2,298					134
17	Jan. 10/53	6:25	(3·21′)	"	34	7·9	40	7	6·0	2·1	2,780	2,181	2·97		176	169
																STATION NO. 18—WOOD
18	Aug. 3/51	7:41			73	8·3 (8·8)	30 (70)	15 (20)			1,338 (1,375)					36·9

[a] Above confluence with Notukeu Creek.

[b] Turbidity due to wind on the lake which is shallow and weedy; sample may have lost slight amount of $CaCO_3$ on storage.

† From field results; sample may have lost some calcium on storage.

TABLE II—Continued

Chemical Analyses of Surface Waters in the Mississippi River Drainage Basin in Canada

(In parts per million)

Magnesium (Mg)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)	Iron (Fe): Dissolved	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Silica (SiO_2): Colorimetric	Hardness as $CaCO_3$: Non-carbonate	Hardness as $CaCO_3$: Total	Sum of constituents	Per cent sodium	Saturation index	Stability index	No.
PAKOWKI LAKE in ALBERTA																		
6·2	186	8·4	.....	31·3	39·2	6·0	.....	.....	500 (503)	7·2 (12)	27	0·0 (0)	86·5 (94·2)	582	80·6	+0·5	6·9	1
LAKE near FLINTOFT, SASK.																		
22·1	266	22·0	0·98	269	17·8	2·0	0·08	.....	442 (459)	30 (38)	7·5 (7·7)	0·0 (0)	125 (127)	868	79·1	+0·9	6·8	2
RIVER near McCORD, SASK.																		
73·2	335	9·6	.....	855	19·2	0·4	.....	.....	288 (305)	38 (36)	4·1	178 (174)	478 (484)	1,547	59·8	+1·5	5·7	3
LAFLÈCHE, SASK.*—Drainage area—2,000 square miles																		
33·4	150	12·6	0·07	338	9·2 (9·0)	1·6	0·60	.....	199 (209)	37 (32)	4·8	22·4 (20·0)	247 (244)	730	55·3	+1·3	6·2	4
126	460	58·0	0·05	1,292	36·5	5·6	0·80	.....	784	0	12	353	995	2,568	48·3	+0·9	5·6	5
139	480	19·0	.....	1,379	37·9	0·1	.....	.....	896	0	15	391	1,125	2,733	47·6	+1·4	5·0	6
3·9	8·0	8·9	.....	16·3	2·4	7·2	.....	.....	63·4	0	5·9	0	47·2	96·4	22·9	−1·3	9·9	7
25·0	118	11·6	0·04	231	8·0	0·0	0·00	.....	273	0	9·1	13·0	237	592	46·4	+0·4	7·1	8
51·5	238	11·5	.....	547	12·6	.....	.....	.....	412	12	8·9	51·5	410	1,164	55·0	+1·3	5·8	9
56·3	306	12·0	0·08	701	14·5	2·0	0·60	.....	245 (271)	38 (34)	4·3	65·8 (57·9)	331 (336)	1,295	65·8	+1·0	6·5	10
58·4	300	13·6	.....	707	16·4	1·2	.....	.....	315	8·9	3·9	94·9	368	1,316	62·9	+0·9	6·4	11
26·8	132	10·6	0·16	285	8·5	2·0	.....	.....	257	0	14	2·2	213	647	55·9	+0·2	7·4	12
33·4	145	11·5	.....	319	10·6	2·0	.....	.....	323	7·5	10	0·0	276	755	52·0	+0·7	6·7	13
38·6	182	12·8	.....	380	12·0	3·0	.....	.....	379	7·4	6·3	0·0	316	892	54·4	+0·9	6·4	14
62·9	235	15·0	0·03	622	20·9	2·0	.....	.....	425	12	5·3	147	515	1,287	48·9	+1·2	5·8	15
78·4	300	17·0	.....	793	21·4	1·6	.....	.....	606	4·8	8·4	152	657	1,656	49·0	+1·3	5·5	16
96·4	375	20·0	0·05	975	27·3	1·7	.....	.....	786	0	13	173	817	2,063	49·1	+1·3	5·3	17
RIVER near COURVAL, SASK.																		
41·0	215	4·1	.....	478	9·3 (9·0)	9·2	.....	.....	242 (193)	15 (38)	4·9	36·7 (46·0)	261 (266)	933	63·7	+0·7	6·9	18

TABLE II—Continued

Chemical Analyses of Surface Waters in the Mississippi River Drainage Basin in Canada

(In parts per million)

No.	Date of collection	Storage period (Days)	Stream discharge (Second-feet): On sampling date	Stream discharge (Second-feet): Monthly mean	Water temperature (°F.)	pH	Colour	Turbidity	Suspended matter: Dried at 105°C.	Suspended matter: Ignited at 550°C.	Specific conductance K x 10⁶ at 25°C.	Residue on evaporation dried at 105°C. (Dissolved solids): P.P.M.	Residue on evaporation dried at 105°C. (Dissolved solids): Tons per acre-foot	Residue on evaporation dried at 105°C. (Dissolved solids): Tons per day	Loss on ignition at 550°C.	Calcium (Ca)
																STATION NO. 19—JOHNSTONE LAKE
1	July 1/52	8:10	.....	.....	65	8·0 (8·6)	..... (45)	150[t] (—)	231	183	1,348	1,006	1·37	.....	122	31·8
[t] Turbidity due to wind on lake. Dissolved oxygen (field test)—8·0 p.p.m.																
																STATION NO. 20.—LAKE FREDERICK
2	July 1/52	8:10	.....	.....	73	8·8 (8·8)	30 (20)	475 (—)	1,526	1,387	96,866	.....	.....	.....	.....	368
																STATION NO. 21—PINTO CREEK
3	July 4/52	6:18	.....	.....	68	8·3 (9·0)	40 (60)	3 (5)	7·9	4·2	2,562	1,972	2·68	.....	162	62·6
Dissolved oxygen (field test)—9·1 p.p.m.																
																STATION NO. 22—BULL CREEK
4	July 5/52	9:18	.....	.....	71	9·0 (9·1)	..... (60)	35 (25)	49	36	2,842	2,018	2·74	.....	73·8	13·6
																STATION NO. 23—RUSSELL CREEK
5	July 5/52	9:17	.....	.....	81	8·7 (8·9)	20 (40)	1 (5)	.....	.....	644 (640)	.....	.....	.....	.....	5·18
Drainage area 2 miles above confluence with Notukeu Creek—120 square miles.																
																STATION NO. 24—NOTUKEU CREEK
6	Aug. 10/51	7:12	.....	.....	69	8·7 (9·2)	20 (90)	15 (20)	12·3	9·0	1,835	1,362	1·85	.....	163	45·9
7	Feb. 6/52	14:14	Normal†	.....	33	8·1	10	5	13	11	1,049	709	0·964	.....	118	103
8	Mar. 5	8:9	(2·15′)	1·23	33	8·0	10	10	.....	.....	1,149	.....	.....	.....	.....	89·0
9	April 2	7:21	(9·51′)	2,355[e]	33	7·6	40	35	.....	.....	192	.....	.....	.....	.....	11·4
10	May 7	7:8	(3·12′)	49·4	52	7·9	30	8	6·4	0·8	1,259	898	1·22	.....	68·8	63·1
11	June 10	7:8	(2·07′)	15·7	58	8·4	20	6	.....	.....	2,157	.....	.....	.....	.....	99·3
12	July 5	4:17	(1·96′)	No record	74	8·4	30	8	.....	.....	2,267	.....	.....	.....	.....	87·2
13	July 5	9:18	.....	"	71	8·0 (8·2)	20 (50)	6 (10)	12·0	8·1	2,208	1,654	2·25	.....	133	93·3
14	Aug. 9	5:11	(1·5′6″)	"	62	8·3	30	7	9·0	5·7	2,403	1,808	2·46	.....	187	83·0
15	Sept. 6	11:17	(1·73′)	"	64	8·3	20	7	.....	.....	2,349	.....	.....	.....	.....	81·7
16	Oct. 7	9:21	(1·98′)	"	41	8·3	30	10	.....	.....	2,788	.....	.....	.....	.....	86·7
17	Nov. 5	8:20	(1·94′)	"	38	8·1	35	15	16·4	8·9	1,573	1,148	1·56	.....	153	68·9
18	Dec. 8	9:46	(1·95′)	"	32	8·2	30	55	.....	.....	1,290	.....	.....	.....	.....	70·2
19	Jan. 7/53	9:29	(1·98′) to ice	"	32	7·8	30	45	29	25	1,430	1,031	1·40	.....	101	84·2

† Values in brackets are gauge levels supplied by the collector.
[e] Estimated—below confluence with Russell Creek.

TABLE II—Continued

Chemical Analyses of Surface Waters in the Mississippi River Drainage Basin in Canada

(In parts per million)

Magnesium (Mg)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)	Iron (Fe): Dissolved	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Silica (SiO_2): Colorimetric	Hardness as $CaCO_3$: Non-carbonate	Hardness as $CaCO_3$: Total	Sum of constituents	Per cent sodium	Saturation index	Stability index	No.
east shore, SASK.																		
40·5	201	24·8	0·21	408	23·0	4·0	.....	.....	320 (317)	4·8 (12)	2·0	0·0 (0)	246 (241)	898	61·2	+0·5	7·0	1
at BISHOPRIC, SASK.																		
7,371	53,500	800	0·08	13,019	3,155	0·0	.....	.....	355	118	0·7	30,765	31,253	78,507	78·3	.....	.....	2
near MEYRONNE, SASK.																		
85·9	410	14·0	0·12	1,097	30·5	1·6	0·80	.....	255 (261)	19 19	3·8	269 (266)	510 (512)	1,851	62·8	+0·95	6·3	3
near CADILLAC, SASK.																		
14·7	638	14·0	1·1	735	11·5	3·0	0·60	.....	642 (611)	110 (121)	6·6	0 (0)	94·6 (99·8)	1,864	92·5	+1·6	5·8	4
near PAMBRUN, SASK.																		
28·8	40·0	10·5	.....	140	5·2	0·3	.....	.....	195 (171)	18·5 (28·8)	3·2	57·5 (62·4)	248 (250)	394	25·0	+1·4	5·9	5
near VANGUARD, SASK.—Drainage area—1,420 square miles.																		
46·0	315	13·6	0·12	668	10·0 (10·0)	2·0	1·0	.....	307 (267)	29 (43)	3·4	3·7 (27·0)	304 (318)	1,285	68·1	+1·3	6·1	6
52·0	58·5	6·2	0·10	186	10·9	2·4	0·04	.....	483	8·4	7·7	60·9	471	673	19·2	+0·2	7·7	7
62·0	85·5	13·8	.....	233	9·0	0·6	.....	.....	514	0	10	56·0	477	756	27·3	+1·0	6·0	8
4·5	13·0	8·2	.....	35·8	2·5	0·3	.....	.....	52·2	0	2·1	4·2	47·0	104	33·0	−0·1	7·8	9
31·0	185	12·0	0·03	380	8·0	0·0	0·20	.....	349	0	9·2	0·0	285	861	55·8	+0·6	6·7	10
63·5	340	12·5	.....	807	12·0	.....	.....	.....	460	13	12	110	509	1,586	58·7	+1·5	5·4	11
62·4	360	12·4	.....	892	13·0	0·6	.....	.....	381	23	11	123	474	1,649	61·5	+1·4	5·6	12
63·2	330	13·0	0·05	838	12·8	0·6	0·80	.....	442 (417)	5·3 (14)	11	122 (133)	493 (499)	1,585	58·5	+1·1	5·8	13
67·8	380	13·0	0·07	954	15·1	0·3	0·70	.....	388	12	5·5	148	486	1,723	62·2	+1·2	5·9	14
70·3	360	13·5	.....	941	13·7	1·2	.....	.....	389	13	4·2	153	493	1,690	60·5	+1·1	6·1	15
70·1	390	12·0	.....	928	15·9	0·8	.....	.....	420	2·4	2·7	156	505	1,716	62·0	+1·2	5·9	16
47·0	220	13·6	0·03	532	10·3	0·3	.....	.....	359	5·5	2·3	62·2	365	1,076	55·6	+0·8	6·5	17
41·6	159	11·0	.....	374	8·1	1·6	.....	.....	389	0	5·1	27·6	346	862	48·9	+1·0	6·2	18
48·5	173	11·0	0·04	425	9·2	1·0	.....	0·10	435	0	8·3	52·9	410	974	47·0	+0·7	6·4	19

TABLE II—Concluded

Chemical Analyses of Surface Waters in the Mississippi River Drainage Basin in Canada

(In parts per million)

No.	Date of collection	Storage period (Days)	Stream discharge (Second-feet): On sampling date	Stream discharge (Second-feet): Monthly mean	Water temperature (°F.)	pH	Colour	Turbidity	Suspended matter: Dried at 105°C.	Suspended matter: Ignited at 550°C.	Specific conductance K x 10^6 at 25°C.	Residue on evaporation dried at 105°C. (Dissolved solids): P.P.M.	Residue on evaporation dried at 105°C. (Dissolved solids): Tons per acre-foot	Residue on evaporation dried at 105°C. (Dissolved solids): Tons per day	Loss on ignition at 550°C.	Calcium (Ca)
																STATION NO. 25—NOTUKEU CREEK near
1	Aug. 3/51	7:12			70	8·4 (8·7)	45 (100)	20 (20)	2·4	19	1,218 (1,220)	818	1·11		126	46·7
2	Feb. 6/52	14:14			33	7·9	8	7	12	10	2,600	1,977	2·69		201	133
3	Mar. 8	5:6	(3·02′)	0	35	7·7	10	12			2,354					149
4	April 28	12:15	(3·02′)	1,790[e]	58	7·6	40	35			535					38·3
5	May 21	8:16	(8·02′)	836	61	8·0	30	15	24	19	1,517	1,097	1·49		88·6	83·7
6	June 4	9:14	(3·96′)	8·4	68	8·3	25	15			1,666					94·2
7	July 4	6:19	(3·34′)	No record	67	8·2 (8·6)	30 (65)	10 (20)	24	19	2,037	1,518	2·06		146	86·3
8	July 9	7:13		"	63	8·1	30	25			2,094					85·0
9	Aug. 6	8:15	(2·76′)	"	70	8·1	20	10	15	11	2,089	1,570	2·14		195	85·0
10	Sept. 3	6:6	(2·78′)	"	60	8·1	30	8			2,460					93·8
11	Oct. 24	10:27	(1·76′)	"	53	8·1	20	15			2,738					113
12	Nov. 14	10:14	(3·54′)	"	35	8·1	25	15	21	17	2,629	2,080	2·83		251	115
13	Dec. 13	4:41	(3·74′) Ice	"	33	8·0	40	45			3,072					139
14	Jan. 23/53	5:50	Ice	"	40	7·8	35	20	15·1	8·1	2,952	2,387	3·25		322	140

Above confluence with Wood River. [e] Estimated.

																STATION NO. 26—WILLOW BUNCH LAKE
15	July 3/52	7:14	Shallow		75	9·2 (9·3)	(50)	70 (—)	192	159	11,452	8,782	11·94		103	14·8[t]

[t] Note field results; samples may have lost some $CaCO_3$ on storage.

																STATION NO. 27—LAKE-OF-THE-RIVERS,
16	July 1/52	8:10			70	8·9 (9·3)	(40)	145 (—)	241	202	3,895	2,037	2·77		117	19·8
																STATION NO. 28—LAKE CHAPLIN
17	July 15/53	7:387			73	9·0 (9·1)	(—)	145 (—)	224	165		47,893	65·1		1,716	6·8
																ADDITIONAL ANALYSES
																1. Creek at
18	Dec. 1944					8·4						1,660	2·6			
																2. WOOD RIVER at
19	Nov. 1944					9·0						1,990	2·71			

TABLE II—Concluded

Chemical Analyses of Surface Waters in the Mississippi River Drainage Basin in Canada

(In parts per million)

Magnesium (Mg)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)	Iron (Fe): Dissolved	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Silica (SiO_2): Colorimetric	Hardness as $CaCO_3$: Non-carbonate	Hardness as $CaCO_3$: Total	Sum of constituents	Per cent sodium	Saturation index	Stability index	No.
GRAVELBOURG, SASK. Drainage area 1,900 square miles.																		
31·2	182	12·4	0·07	315	7·9	2·0	0·50	.....	347 (347)	19 (14)	5·4	0·0 (0)	245 (240)	777	60·3	+1·1	6·2	1
87·3	350	48·0	0·06	924	22·8	2·0	0·60	.....	634	0	6·6	172	691	1,886	50·3	+1·2	5·5	2
95·0	310	10·0	.....	847	20·3	0·4	.....	.....	650	0	11	228	761	1,763	46·5	+1·0	5·7	3
14·3	56·0	10·2	.....	112	2·7	1·2	.....	.....	205	0	12	0·0	154	348	42·1	0	7·6	4
41·3	203	12·5	0·03	446	9·5	1·3	0·40	0·20	419	0	11	34·9	379	1,015	52·8	+0·9	6·2	5
50·9	230	12·5	.....	542	11·7	0·8	.....	.....	455	6·5	8·7	60·6	445	1,182	52·1	+1·3	5·7	6
63·5	306	14·0	0·06	753	13·4	0·8	0·70	.....	378 (420)	24 (9·6)	15	127 (129)	477 (489)	1,464	57·4	+1·2	5·8	7
66·7	305	13·8	.....	786	14·6	0·4	.....	.....	415	4·8	3·6	138	486	1,484	56·8	+1·1	5·9	8
65·7	305	13·0	0·04	817	15·5	0·2	0·60	.....	383	7·2	4·5	157	483	1,503	57·1	+1·0	6·1	9
79·7	360	14·0	.....	977	18·4	0·1	.....	0·00	402	9·6	4·7	217	562	1,755	57·4	+1·0	6·1	10
94·4	390	15·5	.....	1,129	45·8	0·8	.....	.....	438	5·8	3·5	303	671	2,014	55·1	+1·1	5·9	11
93·8	390	14·5	0·03	1,113	20·7	0·8	.....	.....	470	0	4·0	288	673	1,983	55·1	+1·1	5·9	12
100	465	16·5	.....	1,296	23·4	2·0	.....	.....	548	0	8·5	310	759	2,320	56·4	+1·1	5·8	13
96·4	440	18·0	0·04	1,124	21·2	4·0	.....	0·20	693	0	6·9	179	747	2,191	55·4	+1·0	5·8	14
near VERWOOD, SASK.																		
17·6	3,050	50·0	0·05	4,031	815	0·4	0·40	.....	947 (981)	264[1] (240)	5·8 (6·2)	0·0 (0)	109[1] (115)	8,715	97·4	+1·8	5·6	15
northwest shore near ARDILL, SASK.																		
35·0	575	23·5	2·0	805	39·0	2·0	.....	.....	521 (571)	60 (36)	12	0·0 (0)	194 (201)	1,829	84·8	+1·4	6·1	16
near CHAPLIN, SASK.																		
280	14,600	440	0·02	29,580	1,034	20	.....	.....	2,150	31	24	0·0	1,168	47,074	94·8	+1·6	5·8	17
SUPPLIED BY C.P.R. Ponteix, Sask.,																		
.....	.....	.....	.....	876	10·4	.....	.....	.....	.....	.....	.....	.....	486	.....	.....	.....	.....	18
WOOD RIVER, SASK.																		
.....	.....	.....	.....	888	14·8	.....	.....	.....	.....	.....	.....	.....	472	.....	.....	.....	.....	19

TABLE III

Chemical Analyses of Municipal Water Supplies Within the Mississippi River Drainage Basin in Canada

(In parts per million)

No.		Municipality	Milk River, Alta.	Warner, Alta.		
		Source(s)	Well	Deep wells		
			Raw and finished water	Raw and finished water		
No.		Sampling point	Town tap	—	Well No. 1	Well No. 2
1		Date of collection	July 8/52	†	May 26/54	May 26/54
2		Storage period (days)	14:16		5:20	5:20
3		Sampling temperature, °C	13·9		8·3	7·2
4		Test temperature, °C	28·0 (22·0)		21·4	21·4
5		pH	7·8 (7·6)		8·7	8·5
6		Colour	5 (20)		20	5
7		Turbidity	1		1	2
8		Suspended matter, dried at 105°C				
9		Suspended matter, ignited at 550°C				
10		Residue on evaporation, dried at 105°C	789	1,376	1,352	1,451
11		Ignition loss at 550°C	84·6		36·0	36·0
12		Specific conductance (microhoms @ 25°C.)	1,174		2,088	2,214
13		Calcium (Ca)	66·3		1·9	1·7
14		Magnesium (Mg)	31·0		2·5	3·4
15		Iron (Fe) Total				
16		Dissolved	0·52	Trace	0·06	0·07
17		Manganese (Mn)			0	Trace
18		Sodium (Na)	160		555	585
19		Potassium (K)	4·6		8·0	9·0
20		Carbonate (CO_3)	0 (0)	0	28·8	9·8
21		Bicarbonate (HCO_3)	440 (449)	1,256	1,257	1,284
22		Sulphate (SO_4)	262	70	49·2	131
23		Chloride (Cl)	15·6	64	61·1	58·1
24		Fluoride (F)	0·20			
25		Nitrate (NO_3)	0·2	0	0·4	0·4
26		Silica (SiO_2) Colorimetric	13 (11)		7·6	8·4
27		Carbonate hardness, as $CaCO_3$	293 (298)	30	15·0	18·2
28		Non-carbonate hardness, as $CaCO_3$	0·0 (0·0)	0	0·0	0·0
29		Total hardness, as $CaCO_3$	293 (298)	30	15·0	18·2
30		Sum of constituents	771		1,334	1,440
31		Saturation index	+0·8		+0·4	+0·2

Remarks:

† Data supplied by Dept. of Economic Affairs of Alberta.

Ammonia—0 p.p.m.
Albuminoid-Ammonia—0 p.p.m.
Nitrite (NO_2)—0 p.p.m.

TABLE III

Chemical Analyses of Municipal Water Supplies Within the Mississippi River Drainage Basin in Canada

(In parts per million)

Assiniboia, Sask.			Gravelbourg, Sask.		Morse, Sask.	Willow Bunch, Sask.	
Run-off collected by P.F.R.A. dam at Willows			Wells		Deep well	Springs	
Raw water	Finished water		Raw and finished water		Raw and finished water	Raw and finished water	
At pump	—	Plant tap	Town tap		Town tap	Town tap	No.
July 3/52††	Feb. 26/52	July 3/52	July 4/52	June 20/53††	Dec. 24/52††	Jan. 30/53††	1
7:14	.....	7:14	6:19	.....	.....	.....	2
8·9	.....	10·0	10·0	.....	.....	.....	3
25·5 (17·0)	.....	25·3 (13·0)	25·4 (24·0)	.....	.....	.....	4
8·4 (8·7)	7·3	8·2 (8·3)	7·7 (8·0)	7·6	7·8	7·2	5
25 (60)	.....	25 (45)	20 (50)	.....	.....	.....	6
6 (7)	.....	4 (5)	5 (5)	.....	.....	.....	7
13·2	.....	6·4	7·1	.....	.....	.....	8
8·4	.....	0·8	4·2	.....	.....	.....	9
306	649	302	3,304	3,574	2,103	1,663	10
38·4	.....	41·8	235	.....	.....	.....	11
474	.....	497	4,226	.....	.....	.....	12
27·6	45	27·9	166	123	133	118	13
8·8	1	8·4	80·0	77	82	64	14
0·52	.....	0·34	3·7	1·6	.....	.....	15
0·13	0·1	0·09	0·04	.....	0·6	0·2	16
.....	.....	.....	.....	.....	.....	.....	17
57·0	136	56·0	780	880	363	272	18
9·8	12·3	9·8	12·0	10·7	8·3	11·9	19
4·8	0	3·6 (0)	19·2	0	0	0	20
157	257	156 (166)	820	803	822	706	21
88·7	174	87·6	1,602	1,592	670	484	22
4·8	21	5·9	85·2	80	23	4	23
0·20	0·15	0·10	1·2	0·40	0·20	0·20	24
1·6	2·0	0·8	4·0	4	0·0	3·0	25
8·5	0·0	5·6 (4·8)	20	0·0	0·0	0·0	26
105 (107)	117	104 (109)	704 (708)	624	669	558	27
0·0 (0)	0·0	0 (0)	39·7 (35·1)	0·0	0·0	0·0	28
105 (107)	117	104 (109)	744 (743)	624	669	558	29
288	518	283	3,174	3,164	1,684	1,305	30
+0·5	−0·2	+0·4	+1·2	+0·9	+1·2	+0·5	31
		Boron—0·02					

†† Analyses supplied by Dept. of Health of Saskatchewan.

PART II

Churchill River Drainage Basin, 1953-54

DESCRIPTION OF BASIN

The Churchill River system, about 1,000 miles long, drains a relatively large part of Manitoba (14·1 per cent) and Saskatchewan (26·5 per cent) but only a small part of Alberta (Table I, Figures 1 and 2) into Hudson Bay, flowing eastward an average of 150 miles north and 100 miles northeast, and generally parallel to the systems of the Saskatchewan and Nelson Rivers.

Much of the basin lies within the Canadian Shield although most of the settled or accessible portions, (that is, the southwestern tributary basins of the Beaver and Montreal Rivers, lie in the wooded plateau area of the Interior Plains. The Canadian Shield cuts across the lower part of Lac la Ronge and the northern ends of Lac Ile-à-la-Crosse and Churchill Lake in its sweep into the Mackenzie River basin to the western end of Lake Athabasca. Rivers of the system, such as Beaver and Montreal, rising in the Interior Plains flow through a region of sedimentary rock before entering the Canadian Shield. The Shield in much of this basin is broken by areas of greenstone including Archaean sedimentary rocks. The lower reaches of the Churchill River flow through the Hudson Bay Lowland which stops its northward sweep around Hudson Bay at the river's mouth.

The Churchill River system is one of many connecting rivers and lakes, some of the larger lakes being Reindeer—2,444 square miles in area; Peter Pond—302 square miles; Lac Ile-à-la Crosse— 165 square miles; Churchill Lake—213 square miles; Lac la Ronge—450 square miles; Deschaumbault Lake—209 square miles and Cold Lake—136 square miles. The rivers have generally a low gradient followed periodically by falls and rapids and are navigable without portaging for short distances only. The divide between this basin and the Mackenzie River system is considered to pass through Lake Wollaston (768 square miles), Fond-du-Lac River draining the lake to the latter system while Cochrane River drains the lake via Reindeer Lake and Reindeer River into the Churchill River system.

The climate of the basin is typical of other areas of Canada of similar latitude although Hudson Bay has a cooling effect on eastern parts of the basin. Rainfall is adequate and snowfall relatively heavy. Agriculture and cattle raising are important only in the parts of the basin lying in the Interior Plains region. The basin is industrially important because of its potential of mineral resources and water-power in the Canadian Shield. Important deposits of copper and nickel are being developed within the basin near Lynn Lake, Man., and fur-trading is still an important industry in much of the basin. In recent years aircraft and military activity have opened the area to development and settlement and it is now a major tourist area, with a large National Park. Much of the basin is forest covered, but there are extensive areas of muskeg and swamp.

The Churchill River system was in early days used by explorers and fur-traders in their passage westward to the Mackenzie River system.

DESCRIPTION OF MUNICIPAL WATER SYSTEMS

Only one municipality other than the military system at Fort Churchill had an organized water supply when the basin was studied in 1953-54. The available information on these systems is reported below.

DESCRIPTION OF MUNICIPAL WATER SYSTEMS
Within the Churchill River Drainage Basin

Municipality	BONNYVILLE, ALTA.†			FORT CHURCHILL, MAN.
	1951	1952	1956	1956
Population served:				
In municipality	1,250[c]	1,350	1,482[d]	2,000 — 2,500*
Outside municipality	0	0	0	0
Total	1,250	1,350	1,482	2,000 — 2,500
Date(s) of survey	July 1951*†; August 12, 1952			April, 1956.
Ownership	Municipally owned and operated			Owned and operated by the Department of National Defence (Army).
Source of supply	Moose Lake, 3 miles distant			Lake Isabelle, near D.N.D. camp.
Treatment	Water pumped from behind dam on lake to elevated tank and system with chlorination (sodium hypochlorite)			Lake water is prechlorinated, coagulated with alum and activated silica and lime-soda softened in a solid contact reactivator, acid (H_2SO_4) stabilized, pressure filtered (4) to tank and system. Treatment varies with season and in summer (July and August) treatment system except for chlorination and pressure filtration is bypassed. Activated carbon added during run-off (May) and copper sulphate added to lake in fall to control algae.
Storage capacity (thousand gallons)	Moose Lake Elevated tank—50			Elevated tank—50. 2 ground reservoirs—100 each. 1 " " —250.
Consumption (average in m.g.d.)	No information			1955 Domestic....0·227 Max. total.....0·405 Other.....0·043 Plant capacity...0·504 Total.....0·270
Industrial use	A refinery uses the water. Main activities of area are mixed farming, lumbering, trapping and commercial fishing.			No major industrial user.
Remarks	Boundary of village enlarged prior to 1956. * System installed in late 1951. † Data from the Dept. of Economic Affairs of Alberta.			* The National Harbour Board obtain their water from the same source. In late 1956 consideration was being given to use of Churchill River as source of water.

[c] Population according to Ninth Census of Canada, 1951.

[d] Population according to preliminary data, Tenth Census of Canada, 1956.

DISCUSSION

It is seen from Table I and Figures 1 and 3 that the area of the Churchill River drainage basin is appreciable when compared with other major basins in western Canada, it being about one-half the size of the large Mackenzie River basin. The basin drains 26·5 per cent of Saskatchewan and 14·1 per cent of Manitoba but only 2·6 per cent of Alberta. Development of the basin is very limited and only about 45,280 people dwell therein (1951), that is about 1·8 per cent of the population of the prairie provinces. Most of these live in the Interior Plains region of the basin. An appreciable increase in population in the basin was noted in 1956, as a result of military and mining activities.

Table IV details the studies on surface water quality in the area indicating the inaccessible nature of much of the basin and the fact that coverage of this portion is rather meager (Figure 3). It also illustrates the different geological areas of the basin; waters of such rivers as the Beaver are typical of many of the Interior Plains, being hard waters with mineralization caused mostly by calcium carbonate; other waters such as in Cochrane River are typical softer waters of the Canadian Shield. Several of the rivers in the Plains region in this basin do show somewhat higher contents of sodium sulphate than found in other larger rivers of the Plains region such as North, Saskatchewan.

Figure 6 illustrates the changing character of the rivers as they proceed toward the sea. Despite the fact that waters of many tributary rivers, especially those from the north, are softer and lower in total solids than the Beaver River, others such as Makwa, Meadow and Cowan entering from the southern Plains region are of varying hardness but sufficient to maintain the Beaver River as a very hard water almost to its mouth at Lac Ile-à-la-Crosse. It is interesting to note that the large tributary river, Waterhen, flowing parallel but farther north is a softer water. The main system upon entering the Shield has a major inflow from large lakes and rivers within the Shield which rapidly decreases the hardness and mineralization of the main river until it becomes almost a soft water. Continued inflow of very soft water from the north despite inflow of medium-hard water from the relatively large tributary system of the Montreal River results in the main Churchill River becoming very soft by the time it enters Manitoba. This quality persists and, it is presumed, continues to the mouth unless passage through the Hudson Bay Lowlands affects the large river. Unfortuantly information on quality of the river at its mouth is lacking at this time. Although the river water finally becomes typical of waters of the Canadian Shield it does have considerable more mineralization, especially of sodium sulphate, than many other rivers of the Shield such as Rainy River, Ottawa River, etc. This is no doubt due to the inflow and run-off from the Interior Plains area of the basin.

Figure 7 shows the seasonal variation in the headwaters of the system, Beaver River at Beaver Crossing, Alta. Total hardness changes with total mineralization and per cent sodium follows an almost similar curve. In April and again in August periods of low mineralization occur presumably when discharge is high; the lowered mineralization (specific conductance) in August may not be normal for all years. Turbidity was never high in this river during the period of study, a condition not found in many rivers in the Plains area.

Table V reports the analyses of the two organized systems within the basin. Since the system at Fort Churchill is a military installation it has not been included in the statistics of Table VI which show that the one organized public water system supplies only 2·7 per cent of the population of the entire basin with a very hard water.

SUMMARY

The Churchill River Basin has a plentiful supply of water although in the more fertile plains region of the basin the surface waters are relatively hard and contain additional mineralization. Water supply within the basin should give rise to few problems since most waters are suitable without excessive treatment and it appears that turbidity is usually low.

Expected development of the northern regions of Canada will no doubt include development of much of this basin. This is already noted in increased development of water power, mining and tourism. It is probable that additional information on water quality in the now relatively inaccessible areas of the basin will be required at some future date.

TABLE IV

Chemical Analyses of Surface Waters in the Churchill River Drainage Basin

(In parts per million)

No.	Date of collection	Storage period (Days)	Stream discharge (Second-feet) On sampling date	Stream discharge (Second-feet) Monthly mean	Water temperature (°F.)	Oxygen consumed by $KMnO_4$	pH	Colour	Turbidity	Suspended matter Dried at 105°C.	Suspended matter Ignited at 550°C.	Specific conductance K x 10^6 at 25°C.	Residue on evaporation dried at 105°C. (Dissolved solids) P.P.M.	Residue on evaporation dried at 105°C. (Dissolved solids) Tons per acre-foot	Residue on evaporation dried at 105°C. (Dissolved solids) Tons per day	Loss on ignition at 550°C.	Calcium (Ca)
	STATION NO. 1—BEAVER RIVER																
1	Aug. 8/52	13:25	.....	.....	65	.....	7·5 (7·3)	120 (200)	2 (5)	.....	.....	509	408	0·555	.....	99·0	59·3
	STATION NO. 2—BEAVER RIVER																
2	Aug. 12/52	9:21	.....	.....	67	.....	8·0 (8·1)	60 (100)	4 (5)	11·2	6·9	317	222	0·302	.....	63·2	38·7
3	Mar. 23/53	9:77	(3·5′)*	No record	34	.....	7·7	20	5	6·6	2·6	637	407	0·559	.....	64·4	65·6
4	Apr. 10	19:57	(3·5′)	"	32	.....	8·7	35	5	.....	.....	442	.....	.....	.....	.....	44·9
5	May 4	7:35	(12′)	"	50	.....	8·0	50	5	13·9	9·3	332	223	0·303	.....	45·2	46·0
6	May 10	9:33	(7′)	"	50	.....	8·4	60	1	.....	.....	338	.....	.....	.....	.....	36·9
7	June 10	6:9	(6′)	"	70	.....	7·9	40	1	.....	.....	451	.....	.....	.....	.....	53·7
8	July 10	10:35	(4′)	"	79	.....	8·3	40	7	9·5	5·6	410	280	0·381	.....	83·6	45·8
9	Aug. 10	10:80	(7′)	"	67	.....	8·0	80	10	.....	.....	309	.....	.....	.....	.....	39·9
10	Sept. 12	10:59	(7·5′)	"	58	.....	7·7	60	10	.....	.....	360	.....	.....	.....	.....	33·1
11	Oct. 10	9:103	(5·3′)	"	55	.....	8·0	40	8	5·3	2·2	401	.....	.....	.....	.....	44·3
12	Nov. 11	12:117	(5′)	"	32	14	8·0	30	8	.....	.....	456	.....	.....	.....	.....	49·3
13	Dec. 10	7:117	(—)	"	33	14	8·1	30	5	.....	.....	563	.....	.....	.....	.....	60·7
14	Jan. 11/54	ice (5′)	.....	"	31	13	7·6	30	3	2·2	0·7	550	355	0·483	.....	73·0	57·4
15	Feb. 9	10:123 9:97	(3′)	"	33	12	7·8	30	7	.....	.....	595	.....	.....	.....	.....	62·0
	STATION NO. 3—BEAVER RIVER																
16	July 28/53	22:374	High	.....	65	.....	8·2	40	4	.....	.....	392	.....	.....	.....	.....	43·2
	STATION NO. 4—BEAVER RIVER																
17	Aug. 13/52	12:27	.....	.....	68	.....	8·0 (8·2)	50 (75)	4 (10)	.....	.....	370 (380)	.....	.....	.....	.....	43·3
18	Apr. 14/53	15:55	(6′)*	No record	33	.....	7·6	70	5	4·5	0·9	466	308	0·419	.....	64·8	45·2
19	May—No sample taken...																
20	June 10	6:16	Normal	No record	65	.....	7·9	40	1	.....	.....	469	.....	.....	.....	.....	49·9
21	July 27	23:364	(—)	"	67	.....	8·3 (8·5)	40 (60)	5 (—)	.....	.....	447 (450)	.....	.....	.....	.....	49·1

* Value in bracket is gauge level supplied by collector.

Dissolved oxygen (field test)—9·2 p.p.m. at 65°F.

TABLE IV—Continued

Chemical Analyses of Surface Waters in the Churchill River Drainage Basin

(In parts per million)

Magnesium (Mg)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)	Iron (Fe): Dissolved	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Silica (SiO_2): Colorimetric	Hardness as $CaCO_3$: Non-carbonate	Hardness as $CaCO_3$: Total	Sum of constituents	Per cent sodium	Saturation index: +	Saturation index: −	Stability index	No.
near BRIEREVILLE, ALTA.																			
21·3	27·3	7·5	0·21	75·9	19·5	1·0	.....	.....	250	0	4·0	30·6 (37·0)	236 (241)	339	19·4	0·1	.....	7·3	1
at BEAVER CROSSING, ALTA.																			
14·0	10·8	2·0	0·05	8·9	2·3	1·0	.....	0·00	196	2·4	11	0·0 (0)	154 (160)	188	15·3	0·3	.....	7·4	2
25·6	42·5	4·6	0·04	29·1	7·8	4·0	0·30	0·08	389	0	22	0·0	269	393	25·2	0·6	.....	6·5	3
18·4	26·7	5·5	.....	34·0	5·6	1·6	.....	.....	238	11	.....	0·0	188	265	22·9	1·2	.....	6·3	4
11·9	14·0	4·5	0·05	21·3	3·4	1·6	0·10	.....	188	0	7·8	0·0	149	197	16·4	0·4	.....	7·2	5
15·3	14·8	4·9	.....	22·2	3·6	0·6	.....	.....	193	1·7	6·8	0·0	155	202	16·6	0·7	.....	7·0	6
17·0	20·0	3·0	.....	26·1	4·5	0·4	.....	.....	277	0	7·9	0·0	204	269	17·3	0·5	.....	6·9	7
16·7	20·8	3·3	0·04	16·8	3·5	0·1	0·20	.....	254	0	3·1	0·0	183	235	19·4	0·9	.....	6·5	8
11·9	10·5	3·0	.....	12·9	2·3	1·6	.....	.....	190	0	11	0·0	149	187	13·0	0·3	.....	7·4	9
20·8	14·0	3·2	.....	12·6	2·9	2·6	.....	.....	320	0	13	0·0	168	211	15·3	0·1	.....	8·1	10
17·8	18·6	3·9	0·02	18·3	1·8	1·2	0·30	.....	243	0	11	0·0	184	236	17·6	0·5	.....	7·0	11
20·0	21·0	3·9	.....	20·2	4·5	2·4	.....	.....	277	0	8·4	0·0	205	266	17·9	0·6	.....	6·8	12
23·9	29·6	5·0	.....	27·2	7·2	3·2	.....	.....	347	0	15	0·0	250	343	20·0	0·8	.....	6·5	13
23·5	29·0	4·0	0·05	28·5	5·4	2·4	0·00	.....	326	0	14	0·0	240	325	20·5	0·2	.....	7·2	14
26·1	35·5	4·5	.....	28·1	7·1	3·2	.....	.....	364	0	13	0·0	262	358	22·4	0·6	.....	6·6	15
south of GOODSOIL, SASK.																			
14·2	17·6	2·8	.....	12·4	2·5	1·6	0·10	.....	252	0	10	0·0	165	228	18·5	0·6	.....	7·0	16
at BARNES CROSSING, SASK.																			
17·2	12·0	2·8	.....	8·2	2·5	1·0	.....	.....	231	0	10	0·0 (0)	179 (190)	210	12·5	.....	0·4	7·2	17
22·0	21·7	7·7	0·07	31·2	5·5	2·0	0·20	0·00	263	0	15	0·0	203	281	18·1	.....	0·1	7·4	18
																			19
23·0	19·5	4·2	.....	22·8	4·3	1·0	.....	.....	288	0	6·8	0·0	219	274	15·9	.....	0·5	6·9	20
25·1	22·1	3·7	.....	17·5	3·4	1·2	0·10	.....	291 (283)	0 (0)	10	0·0	226	276	17·3	.....	0·9	6·5	21

TABLE IV—Continued

Chemical Analyses of Surface Waters in the Churchill River Drainage Basin

(In parts per million)

No.	Date of collection	Storage period (Days)	Stream discharge (Second-feet)		Water temperature (°F.)	Oxygen consumed by $KMnO_4$	pH	Colour	Turbidity	Suspended matter		Specific conductance $K \times 10^6$ at 25°C.	Residue on evaporation dried at 105°C. (Dissolved solids)			Loss on ignition at 550°C.	Calcium (Ca)
			On sampling date	Monthly mean						Dried at 105°C.	Ignited at 550°C.		P.P.M.	Tons per acre-foot	Tons per day		
	STATION NO. 4—BEAVER RIVER																
1	Aug. 23	16:79	Normal	"	71	.....	7·9	70	6	.....	.....	401	.....	.....	.....	.....	47·5
2	Sept.—No sample taken.																
3	Oct. 17	11:96	(1′ < Normal)	"	42	.....	7·6	50	15	10·7	3·7	350	.....	.....	.....	.....	34·2
4	Nov.—No sample taken.																
5	Dec. 10	7:117	Low	"	33	15	8·1	40	15	.....	.....	653	.....	.....	.....	.....	67·5
6	May 15/54	11:25	Very high	"	41	.....	8·2	10	20	49·7	49·2	233	175	0·238	.....	62·2	24·8
	STATION NO. 5—BEAVER RIVER (LAC ILE-À-LA-CROSSE)																
			Water elevation in feet														
7	June 22/53*	11:50	.....	98·71	62	.....	8·4	40	3	.....	.....	390	259	0·352	.....	85·8	38·8
8	July 22	13:37	.....	98·71	68	.....	8·2	40	7	.....	.....	363	.....	.....	.....	.....	36·2
9	Aug. 13†	12:95	.....	98·70	72	.....	8·0	5	4	.....	.....	278	.....	.....	.....	.....	31·3
10	Aug. 20	5:57	.....	98·70	75	.....	8·2	50	5	5·3	3·1	338	234	0·318	.....	78·6	36·8
11	Sept. 30	20:98	.....	98·74	50	.....	8·2	30	15	.....	.....	321	.....	.....	.....	.....	33·6
12	May 17/54††	133:149	.....	.....	49	17	7·2	65	2	.....	.....	269	206	0·280	.....	51·0	26·3
	STATION No. 6 CHURCHILL RIVER																
13	July 6/53	8:36	4·75†	.....	64	.....	7·9	20	4	3·2	1·9	165	113	0·154	.....	27·4	16·0
14	Aug. 3	57:99	4·85	.....	.....	.....	8·2	10	4	.....	.....	180	.....	.....	.....	.....	18·6
15	May 24*	115:149	4·50	.....	38	9·0	9·0	15	2	.....	.....	204	.....	.....	.....	.....	21·7
	STATION NO. 7—CHURCHILL RIVER at ISLAND																
16	April 20/53	12:49	17,000	17,500	32	.....	7·8	10	0	.....	.....	84·0	52·2	0·07	2,465	16·0	9·1
17	May 20	7:30	17,600	19,000	46	.....	7·8	5	0	.....	.....	73·3	.....	.....	.....	.....	8·7
18	June 20	13:53	18,300	18,400	57	.....	7·9	10	5	.....	.....	73·1	.....	.....	.....	.....	6·8
19	July 21	5:34	18,200	18,700	66	.....	7·7	20	6	3·2	1·3	92·3	57·2	0·078	2,803	22·8	6·6
20	Aug.—No sample taken	.....	.....	18,100													
21	Sept. 20	9:105	18,500	17,500*	55	.....	7·6	10	7	.....	.....	90·3	.....	.....	.....	.....	8·5
22	May 15/54	10:25	.....	.....	35	7·1	8·2	10	1	.....	.....	75·9	56·0	0·076	.....	24·4	6·8

* Collector's estimate of level or flow.

† Lac-à-La-Crosse near north end.

†† Aluminum—0·02 p.p.m.

* Low water sample.

* Aluminum—0·1 p.p.m.

†Collector's reading of river level.

* Also yearly mean.

TABLE IV—Continued

Chemical Analyses of Surface Waters in the Churchill River Drainage Basin

(In parts per million)

Magnesium (Mg)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)	Iron (Fe): Dissolved	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Silica (SiO_2): Colorimetric	Hardness as $CaCO_3$: Non-carbonate	Hardness as $CaCO_3$: Total	Sum of constituents	Per cent sodium	Saturation index: +	Saturation index: −	Stability index	No.
at BARNES CROSSING, SASK.—*Continued*																			
16·8	13·8	3·6	.....	16·3	3·0	1·4	.....	00·0	241	0	15	0·0	188	236	13·5	.....	0·4	7·1	1
																			2
17·3	16·9	3·6	0·02	9·2	1·8	10·0	0·40	.....	215	0	20	0·0	157	219	18·5	.....	0·1	7·8	3
																			4
32·6	31·2	6·0	.....	32·5	7·4	3·2	.....	.....	413	0	14	0·0	303	398	17·9	.....	0·9	6·3	5
11·2	6·5	5·8	0·20	15·2	2·2	2·0	.....	.....	131	0	7·5	1·0	108	140	10·9	.....	0·1	8·0	6
at mouth near ILE-À-LA-CROSSE, SASK.																			
18·8	16·6	4·7	0·09	23·4	5·6	0·8	0·03	.....	226	1·2	8·3	0·0	174	229	16·7	0·8	.....	6·8	7
17·7	16·5	3·9	.....	14·8	4·4	0·0	.....	0·00	216	0	5·7	0·0	163	206	17·6	0·5	.....	7·2	8
10·3	14·8	4·8	0·02	14·0	6·3	1·4	.....	.....	166	0	.....	0·0	121	.....	20·3	0·2	.....	7·6	9
16·5	13·0	3·0	0·04	13·3	3·5	3·0	.....	.....	207	0	7·5	0·0	160	199	14·7	0·6	.....	7·0	10
15·0	15·6	3·6	.....	14·9	5·2	1·6	.....	0·02	191	0	11	0·0	146	195	18·4	0·5	.....	7·2	11
12·8	12·6	5·6	0·08	19·0	2·7	3·2	.....	.....	148	0	24	0·0	118	179	17·9	.....	0·8	8·8	12
at STANLEY MISSION, SASK.																			
7·0	8·5	2·3	0·02	9·1	4·0	0·8	0·01	0·02	93	0	7·9	0·0	68·9	101	20·5	.....	0·5	8·9	13
7·8	7·6	2·3	.....	6·2	4·0	1·6	.....	0·00	101	0	11	0·0	78·0	109	16·9	.....	0·3	8·8	14
8·0	11·5	1·9	0·02	4·4	3·0	0·4	0·20	.....	91·7	17	.....	0·0	87·0	.....	21·9	0·9	.....	7·2	15
FALLS, SASK.—Drainage area 71,000 square miles																			
3·4	4·2	1·4	0·05	4·3	1·1	0·6	0·05	0·00	50·3	0	12	0·0	36·8	60·6	19·2	.....	1·0	9·8	16
4·4	2·5	1·0	.....	7·0	1·6	0·4	.....	.....	38·8	0	3·0	8·2	40·0	48·5	11·7	.....	1·2	10·2	17
3·7	3·2	1·3	.....	3·8	1·2	0·1	.....	0·00	41·5	0	3·8	0·0	32·1	44·4	17·0	.....	1·1	10·1	18
3·5	1·6	0·03	4·9	1·6	0·1	.....	.....	41·0	.....	0	2·8	0·0	30·8	44·8	18·8	.....	1·3	10·7	19
																			20
3·1	5·0	2·5	.....	5·1	1·2	0·8	.....	0·00	48·1	0	14	0·0	34·0	63·9	22·5	.....	1·3	10·2	21
3·7	3·9	1·5	0·04	1·0	1·9	0·8	0·05	.....	46·8	0	4·4	0·0	32·3	47·2	19·8	.....	0·8	9·8	22

TABLE IV—Continued

Chemical Analyses of Surface Waters in the Churchill River Drainage Basin

(In parts per million)

No.	Date of collection	Storage period (Days)	Stream discharge (Second-feet): On sampling date	Stream discharge (Second-feet): Monthly mean	Water temperature (°F.)	Oxygen consumed by $KMnO_4$	pH	Colour	Turbidity	Suspended matter: Dried at 105°C.	Suspended matter: Ignited at 550°C.	Specific conductance $K \times 10^6$ at 25°C.	Residue on evaporation dried at 105°C. (Dissolved solids): P.P.M.	Residue on evaporation dried at 105°C. (Dissolved solids): Tons per acre-foot	Residue on evaporation dried at 105°C. (Dissolved solids): Tons per day	Loss on ignition at 550°C.	Calcium (Ca)
	STATION NO. 8—CHURCHILL RIVER above GRANVILLE																
1	June 13/53*	6:19	23,800	23,700	57	.....	7·7	20	4	1·6	0·0	69·1	53·8	0·07	3,451	27·2	8·0
2	June 13	6:32	23,800	23,700	56	.....	7·8	20	5	5·3	1·7	70·8	53·4	0·073	3,427	22·6	8·0
3	July 22	9:37	23,700	23,700	64	.....	7·5	20	8	.....	.....	80·9	.....	.....	.....	.....	7·6
4	Aug.—No sample taken	.....	.....	24,000													
5	Sept. 23	6:48	22,900	22,500	50	.....	7·7	10	20	.....	.....	82·1	.....	.....	.....	.....	8·5
6	Feb. 12/54	13:104	20,900	.....	34	6·0	7·7	2	3	.....	.....	101	83·0	0·113	4,661	41·4	9·9
	STATION NO. 9—AMISK RIVER																
7	Aug. 8/52	13:25	.....	.....	71	.....	7·9 (8·0)	80 (75)	2 (5)	.....	.....	391 (390)	298	0·405	.....	90·0	39·8
	STATION NO. 10—MOOSE LAKE																
8	June 14/51*	.....	.....	.....	.....	.....	8·4	15	Slight	.....	.....	.....	564	0·767	.....	70·0	28·0
9	Aug. 12/52	9:21	.....	.....	52	.....	8·7 (8·6)	10 (25)	1 (5)	.....	.....	745 (745)	515	0·700	.....	25·6	26·9
	STATION NO. 11—MAKWA LAKE																
10	July 27/53	23:377	.....	.....	67	.....	8·5	10	2	.....	.....	570	.....	.....	.....	.....	30·4
	STATION NO. 12—MAKWA RIVER																
11	Aug. 13/52	8:33	.....	.....	66	.....	7·8 (7·8)	120 (200)	1 (25)	.....	.....	518 (524)	394	0·536	.....	42·8	62·7
	STATION NO. 13—MEADOW RIVER																
12	July 1945	(Analysis supplied by C.P.R.)			.....	.....	.....	.....	.....	.....	.....	.....	300	0·408	.....	.....	.....
13	Aug. 15/52	11:34	.....	.....	69	.....	8·1 (8·7)	35 (75)	10 (20)	20	11	375 (380)	267	0·363	.....	83·2	38·9

* At Granville Lake.

* Analysis supplied by Department of National Health and Welfare, Ottawa.

TABLE IV—Continued

Chemical Analyses of Surface Waters in the Churchill River Drainage Basin

(In parts per million)

Magnesium (Mg)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)	Iron (Fe): Dissolved	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Silica (SiO_2): Colorimetric	Hardness as $CaCO_3$: Non-carbonate	Hardness as $CaCO_3$: Total	Sum of constituents	Per cent sodium	Saturation index: +	Saturation index: −	Stability index	No.
FALLS, MAN.—Drainage area—82,000 square miles																			
2·6	5·0	1·6	0·16	4·0	1·1	0·3	0·00	.....	44·9	0	5·3	0·0	30·8	50·2	25·0	.....	1·2	10·1	1
2·7	3·0	1·3	0·04	4·2	1·7	0·3	0·10	.....	38·8	0	3·6	0·0	31·2	44·0	16·5	.....	1·1	10·0	2
2·7	4·5	1·9	.....	3·1	2·1	0·2	.....	0·00	42·7	0	3·2	0·0	30·0	45·3	23·2	.....	0·7	10·5	3
3·2	3·7	1·7	.....	2·9	1·0	1·0	.....	0·00	47·8	0	5·7	0·0	34·4	51·2	18·0	.....	1·2	10·1	5
3·9	5·6	1·8	0·02	2·6	2·6	3·2	0·00	.....	58·0	0	3·9	0·0	40·6	62·1	22·1	.....	1·1	9·9	6
near BRIEREVILLE, ALTA.																			
17·4	19·5	5·4	0·08	28·1	3·6	1·0	.....	.....	223	0	5·6	0·0 (0)	171 (181)	230	19·3	0·3	.....	7·3	7
near BONNYVILLE, ALTA.																			
45·3	87·1 as Na		0·12	116	14·5	0·0	0·03	.....	366	12	3·2	0·0	256	477	.....	0·8	.....	6·8	8
41·6	77·0	11·1	0·06	117	13·8	1·4	0·20	.....	293	23	3·4	0·0 (0)	238 (254)	460	39·6	1·1	.....	6·5	9
near LOON LAKE, SASK.																			
39·4	23·0	8·9	.....	40·1	4·5	2·0	0·10	.....	284	7·2	7·5	0·0	237	303	16·8	0·9	.....	6·7	10
near RAPID VIEW, SASK.																			
29·1	14·0	3·0	0·12	22·2	3·0	0·8	.....	.....	338	0	8·4	0·0	276 (286)	310	9·8	0·5	.....	6·8	11
at MEADOW LAKE, SASK.																			
.....	.....	.....	.....	18·4	5·2	.....	.....	.....	244	0	.....	11·4	212	.....	.....	.....	.....	.....	12
19·9	11·0	5·1	0·02	26·1	2·2	3·0	.....	.....	205	3·6	12	5·2	179 (185)	223	11·4	0·5	.....	7·1	13

TABLE IV—Continued

Chemical Analyses of Surface Waters in the Churchill River Drainage Basin

(In parts per million)

No.	Date of collection	Storage period (Days)	Stream discharge (Second-feet) On sampling date	Stream discharge (Second-feet) Monthly mean	Water temperature (°F.)	Oxygen consumed by $KMnO_4$	pH	Colour	Turbidity	Suspended matter Dried at 105°C.	Suspended matter Ignited at 550°C.	Specific conductance $K \times 10^6$ at 25°C.	Residue on evaporation dried at 105°C. (Dissolved solids) P.P.M.	Residue on evaporation dried at 105°C. (Dissolved solids) Tons per acre-foot	Residue on evaporation dried at 105°C. (Dissolved solids) Tons per day	Loss on ignition at 550°C.	Calcium (Ca)
	STATION NO. 14—COLD LAKE at COLD LAKE, ALTA																
1	Aug. 12/52	9:21			63		8·4 (8·4)	0 (5)	1			259 (257)	250	0·340		117	31·3
2	Mar. 25/53	16:59		No record	32		8·3	10	Slight			309	184	0·250		30·4	36·0
3	April 17/53	13:52 (10′)	†	"	35		8·3	5	1			240	149	0·203		25·6	28·9
4	May 15	7:35 (4′)		"	48		8·5	5	0			266					47·2
5	June 19	26:70 (10′)		"	53		8·4	5	2			273					30·2
6	July 23	8:38 (10′)		"	58		8·4	5	4	3·0	0·4	259	160	0·218		31·8	30·0
7	Aug. 22	11:80 (10′)		"	79		8·6	5	3			258					30·3
	† Collector's report on lake level.																
	STATION NO. 15—WATERHEN RIVER																
8	Aug. 13/52	8:35	818†	799†	69		7·9 (7·9)	10 (20)	1 (25)			282 (290)	179	0·243	394·3	39·0	31·2
9	April 14/53	15:55	234	238	33		7·9	10	0			377	230	0·313	144·8	34·0	41·0
10	May	No sample taken		308													
11	June 10	6:16	338	384	72		8·2	20	1			285					31·7
12	July 27	22:364	580	492	67		8·2 (8·0)	30 (—)	2 (—)			258 (270)					26·5
13	Aug. 23	16:79	640	645	72		7·9	10	3			274					30·7
14	Sept.	No sample taken		532													
15	Oct. 17	11:96			42	8·9	7·8	5	3	1·6	0·4	307					33·9
16	Nov.	No sample taken															
17	Dec. 10	7:117	Low		36	6·5	8·1	10	3			336					37·4
18	May 15/54	11:25	5′ below normal		51	9·9	8·3	20	3	28	14	303	192	0·261		50·4	33·2
	† Records at outlet of Cold Lake.																
	STATION NO. 16—FLOTTEN LAKE																
19	July 27/53	22:375			67		7·6 (7·8)	30 (—)	3 (—)			286					30·0
	STATION NO. 17—GREEN LAKE																
20	July 26/53	24:376			65		8·7	5	3			378					37·1
	STATION NO. 18—COWAN LAKE																
21	July 25/53†	17:377			65		8·4	40	6			571					41·3
	† Almost stagnant water.																

TABLE IV—Continued

Chemical Analyses of Surface Waters in the Churchill River Drainage Basin

(In parts per million)

Magnesium (Mg)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)	Iron (Fe): Dissolved	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Silica (SiO_2): Colorimetric	Hardness as $CaCO_3$: Non-carbonate	Hardness as $CaCO_3$: Total	Sum of constituents	Per cent sodium	Saturation index: +	Saturation index: −	Stability index	No.
Drainage area at Waterhen River outlet of Cold Lake, 2,160 sq. miles																			
10·7	8·5	1·9	0·04	4·9	0·9	0·7	0·10	.....	150	8·4	4·6	0·0	122 (127)	146	12·9	0·5	.....	7·4	1
12·8	10·0	3·2	0·04	5·5	1·1	1·2	0·05	0·01	196	0	3·2	0·0	143	170	12·9	0·6	.....	7·1	2
9·4	8·0	2·2	0·03	4·7	1·1	0·8	0·05	0·04	149	0	7·1	0·0	111	135	13·3	0·4	.....	7·5	3
2·3	8·6	1·7	.....	4·3	0·9	0·6	.....	.....	155	4·3	4·6	0·0	127	151	12·6	0·8	.....	6·9	4
12·0	10·5	2·4	.....	4·3	1·2	0·6	.....	.....	167	4·3	3·0	0·0	125	151	15·2	0·6	.....	7·2	5
10·1	10·2	2·9	0·06	5·4	0·7	0·1	0·05	.....	161	4·3	4·8	0·0	117	148	15·6	0·5	.....	7·4	6
10·4	9·2	2·4	.....	3·9	0·8	0·8	.....	0·00	156	5·0	5·4	0·0	119	145	14·1	0·9	.....	6·8	7
north of DORINTOSH, SASK.																			
12·6	9·5	2·4	0·08	6·9	1·5	0·5	0·20	.....	170	2·9	5·4	0·0	130 (133)	157	13·5	0·1	.....	7·7	8
17·6	11·9	3·8	0·03	11·2	1·6	1·6	0·05	0·00	228	0	14	0·0	175	215	12·6	0·3	.....	7·3	9
																			10
12·9	10·3	1·2	.....	6·8	0·8	0·6	.....	0·07	175	0	5·6	0·0	132	156	14·3	0·5	.....	7·2	11
13·2	11·8	2·4	.....	7·0	1·3	1·2	0·05	.....	167	0	5·6	0·0	121 (119)	151	17·2	0·3	.....	7·6	12
10·5	9·8	2·8	.....	6·4	0·5	0·8	.....	0·00	168	0	5·2	0·0	120	150	14·7	0	.....	7·8	13
																			14
13·6	10·8	3·2	0·02	9·1	0·4	1·2	0·10	.....	190	0	4·0	0·0	141	170	13·9	0·1	.....	7·6	15
																			16
15·0	13·3	3·6	.....	10·1	2·4	1·6	.....	.....	214	0	4·2	0·0	156	193	15·3	0·4	.....	7·3	17
14·6	9·9	3·3	0·02	9·4	0·6	1·6	0·00	.....	194	0	5·2	0·0	143	173	12·8	0·5	.....	7·3	18
north of DORINTOSH, SASK.																			
15·5	9·7	3·2	.....	4·3	0·9	3·0	0·00	.....	191	0	7·1	0·0 (0)	139 (139)	168	12·9	.....	0·2	8·0	19
at GREEN LAKE, SASK.																			
17·9	19·7	5·2	.....	20·6	9·9	1·6	0·15	.....	193	12	13	0·0	166	232	19·9	1·0	.....	6·7	20
at BIG RIVER, SASK.																			
37·3	25·0	6·6	.....	75·3	2·7	3·0	0·20	.....	288	3·4	8·9	14·6	257	347	17·0	1·0	.....	6·4	21

TABLE IV—Continued

Chemical Analyses of Surface Waters in the Churchill River Drainage Basin

(In parts per million)

No.	Date of collection	Storage period (Days)	Stream discharge (Second-feet): On sampling date	Stream discharge (Second-feet): Monthly mean	Water temperature (°F.)	Oxygen consumed by $KMnO_4$	pH	Colour	Turbidity	Suspended matter: Dried at 105°C.	Suspended matter: Ignited at 550°C.	Specific conductance K x 10^6 at 25°C.	Residue on evaporation dried at 105°C. (Dissolved solids): P.P.M.	Tons per acre-foot	Tons per day	Loss on ignition at 550°C.	Calcium (Ca)
	SATTION NO. 19—WASKESIU LAKE																
1	July 24/53	8:—			66		8·6 (8·3)	10 (—)	2 (—)			312					31·7
	STATION NO. 20—MONTREAL LAKE																
2	Aug. 16/52	9:32			61		8·1 (8·3)	20 (25)	7 (10)	13·2	7·5	306	215	0·292		62·2	32·3
3	Feb./53	No sample taken															
4	Mar.	No sample taken															
5	April 18	12:52	Normal				8·4	10	0			360	242	0·329		59·0	44·4
6	May 27	8:23	High		53		8·0	10	1			311					33·5
7	June 20*	6:25	Normal		59		7·5	20	4			304					30·4
8	July 24	18:384			67		8·3 (8·4)	30 (50)	15 (20)			311 (335)					32·9
9	July 29*	8:34	Low		61		7·9		15	32	17	304	207	0·282		65·2	39·0
10	Aug.—	Sample lost in transit															
11	Sept. 22	7:79	Low		49		8·1	10	15			297					29·1
12	Oct. 17	9:107	"		47		7·8	5	6			308					30·3
13	Nov. 24	8:83	"		32		8·5	10	15	3·5	0·6	333	218	0·296		62·6	34·4
14	Dec.	No sample taken															
15	Jan. 23/54	6:98	Low		32	12	8·1	10	2			398					39·4
16	Feb. 25	5:81	"		32	14	8·1	5	2			396					38·2
17	Mar. 25	9:55	"		34		8·3	15	2			444	389	0·529		81·2	46·2
	STATION NO. 21—LAC LA RONGE		Water elevation in feet														
18	Aug. 16/52	9:52		200·46	59		7·8 (8·0)	20 (40)	2 (5)			248 (250)	185	0·252		55·2	31·2
19	June 16/53	10:29		199·64	54		7·9	10	3	5·3	2·7	212	130	0·177		30·6	27·2
20	July 16	11:43		199·83	64		8·4	10	6			218					25·3
21	Aug. 16	9:86		199·92	69		8·2	5	3			207					26·7
22	Sept. 17	12:74		199·81	55		7·8	10	4	4·4	2·5	210	130	0·177		27·4	25·6
23	May 25/54	114:150			38	7·2	9·2	4	2			210					22·5

TABLE IV—Continued

Chemical Analyses of Surface Waters in the Churchill River Drainage Basin

(In parts per million)

Magnesium (Mg)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)	Iron (Fe): Dissolved	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Silica (SiO_2): Colorimetric	Hardness as $CaCO_3$: Non-carbonate	Hardness as $CaCO_3$: Total	Sum of constituents	Per cent sodium	Saturation index: +	Saturation index: −	Stability index	No.
at WASKESIU, SASK.																			
16·4	.....	.....	.....	.....	.....	.....	.....	.....	186 (181)	4·6 (0)	.....	0·0 (0)	146 (147)	.....	.....	.....	.....	.....	1
near MONTREAL LAKE, SASK.																			
16·7	7·1	3·2	0·02	4·3	2·0	1·0	0·40	.....	185	6·0	3	0·0	150 (157)	177	9·1	0·4	.....	7·3	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
18·6	9·8	4·0	0·03	6·3	2·0	0·8	0·05	0·00	231	4·8	16	0·0	187	221	10·0	0·9	.....	6·6	5
17·3	6·9	2·5	.....	7·4	1·8	0·4	.....	.....	195	0	11	0·0	155	177	8·7	0·2	.....	7·8	6
17·7	9·0	3·5	.....	4·1	1·8	1·2	.....	0·00	202	0	6·4	0·0	149	168	11·3	.....	0·5	8·5	7
16·6	8·7	3·8	0·01	6·6	1·7	3·0	0·10	.....	199	0	13	0·0	150 (147)	185	10·6	0·6	.....	7·1	8
11·7	9·0	4·0	0·03	5·4	1·3	3·0	0·10	.....	200	0	9·8	0·0	145	182	11·5	0·3	.....	7·3	9
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
16·9	8·4	3·8	.....	4·5	1·3	2·4	.....	0·04	191	0	17	0·0	142	173	11·1	0·3	.....	7·5	11
17·3	8·5	3·5	.....	4·1	1·2	1·4	.....	.....	195	0	13	0·0	147	176	10·9	0·0	.....	7·8	12
18·9	10·1	4·2	0·01	6·6	2·1	1·6	.....	.....	214	5·8	12	0·0	164	201	11·5	0·9	.....	6·7	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
22·8	9·3	4·4	.....	7·0	1·8	1·2	.....	.....	246	0	10	0·0	192	217	9·3	0·5	.....	7·1	15
25·2	10·2	4·4	.....	5·1	2·1	3·2	.....	.....	262	0	10	0·0	201	228	9·7	0·6	.....	6·9	16
25·7	11·1	5·3	0·03	4·7	1·0	1·6	0·00	.....	294	0	11	0·0	221	251	9·6	0·8	.....	6·7	17
MONTREAL RIVER) near LA RONGE, SASK.																			
10·8	5·1	2·2	0·08	4·0	2·0	0·7	.....	.....	153	0	15	0·0	123 (129)	147	8·1	0·0	.....	7·8	18
8·5	5·2	2·3	0·12	4·9	1·6	0·6	0·10	.....	137	0	1·7	0·0	103	120	9·7	0·0	.....	7·9	19
9·7	6·3	2·7	.....	4·1	1·8	0·4	.....	0·00	133	1·2	5·9	0·0	103	123	11·4	0·5	.....	7·4	20
7·6	3·6	2·3	.....	3·7	2·1	1·2	.....	.....	124	0	5·5	0·0	978	114	7·2	0·2	.....	7·8	21
8·8	4·5	2·6	0·01	5·0	0	1·6	0·10	.....	126	0	6·5	0·0	100	117	8·6	.....	0·3	8·4	22
9·1	8·3	1·1	0·02	0·5	1·1	0·6	0·15	.....	82·7	24	.....	0·0	94·1	150	16·0	1·1	.....	7·0	23

TABLE IV—Concluded

Chemical Analyses of Surface Waters in the Churchill River Drainage Basin

(In parts per million)

No.	Date of collect on	Storage period (Days)	Stream discharge (Second-feet): On sampling date	Stream discharge (Second-feet): Monthly mean	Water temperature (°F.)	Oxygen consumed by $KMnO_4$	pH	Colour	Turbidity	Suspended matter: Dried at 105°C.	Suspended matter: Ignited at 550°C.	Specific conductance $K \times 10^6$ at 25°C.	Residue on evaporation dried at 105°C. (Dissolved solids): P.P.M.	Residue on evaporation dried at 105°C. (Dissolved solids): Tons per acre-foot	Residue on evaporation dried at 105°C. (Dissolved solids): Tons per day	Loss on ignition at 550°C.	Calcium (Ca)
	STATION NO. 22—UPPER FOSTER																
			Water elevation in feet														
1	May 15/53	10:35	.....	.....	44	.....	7·3	5	1	.....	.....	31·9	38·6	0·052	.....	17·4	3·2
2	June—	No sample taken	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	July—	No sample taken	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4	Aug. 13	12:95	.....	.....	63	.....	7·3	5	4	.....	.....	38·1	.....	.....	.....	.....	3·6
	STATION NO. 23—																
			Water elevation in feet														
5	Aug. 12/53	13:96	.....	91·98	65	.....	7·9	5	3	.....	.....	35·4	.....	.....	.....	.....	2·6
	* Sampled at north end of the lake.																
	STATION NO. 24—COCHRANE RIVER																
6	Aug. 12/53	13:104	1′ below normal	.....	64	.....	9·3	5	3	.....	.....	48·1	66·0	0·090	.....	16·8	4·9
	STATION NO. 25—REINDEER LAKE																
			Water elevation in feet														
7	June 22/53	8:23	.....	109·84	52	.....	7·0	10	3	.....	.....	30·6	39·2	0·053	.....	21·6	2·8
8	July 14	8:41	(220′)	109·97	63	.....	7·1	10	4	.....	.....	30·9	.....	.....	.....	.....	1·6
9	Aug. 10	9:59	(—)	109·95	64	.....	7·2	10	2	.....	.....	28·2	.....	.....	.....	.....	2·9
10	Sept. 28	9:107	(—)	109·92	46	.....	7·2	10	5	2·1	0·2	30·0	27·2	0·037	.....	11·2	2·4
11	June 16/54	93:119	(214′) ..... (1·91)	.....	58	7·4	7·1	15	2	.....	.....	39·4	37·8	0·051	.....	14·4	3·6
	STATION NO. 26—REINDEER LAKE at outlet of REINDEER																
12	May 27/53	8:30	10,500	10,500	47	.....	7·3	5	0	.....	.....	33·9	27·6	0·038	777·0	12·8	2·7
13	June 22	11:50	10,600	10,600	50	.....	6·8	10	0	.....	.....	31·1	.....	.....	.....	.....	2·5
14	July 27	10:73	10,600	10,600	60	.....	7·3	20	2	.....	.....	30·9	.....	.....	.....	.....	1·9
15	Aug. 24	15:92	10,600	10,600	65	.....	7·2	10	2	.....	.....	31·2	27·2	0·037	773·8	12·4	3·0
16	Sept.	No sample taken		10,600	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	Oct.	No sample taken		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
18	Nov.	No sample taken		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
19	May 15/54	124:151	.....	.....	36	7·3	7·7	15	3	.....	.....	43·9	74·2	.....	.....	18·2	3·4

TABLE IV—Concluded

Chemical Analyses of Surface Waters in the Churchill River Drainage Basin

(In parts per million)

Magnesium (Mg)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)	Iron (Fe): Dissolved	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Silica (SiO_2): Colorimetric	Hardness as $CaCO_3$: Non-carbonate	Hardness as $CaCO_3$: Total	Sum of constituents	Per cent sodium	Saturation index: +	Saturation index: −	Stability index	No.
LAKE at FOSTER LAKE, SASK.																			
2·5	0·9	0·2	0·05	3·6	0·2	1·6	0	.....	15·9	0	9·0	5·4	18·4	30·3	9·5	.....	2·5	12·3	1
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
1·3	3·6	2·3	0·01	3·3	0·2	0·8	0·10	.....	24·4	0	18	0·0	14·3	44·7	31·4	.....	2·2	11·7	4
WOLLASTON LAKE,* SASK.																			
1·8	.....	2·5	0·06	5·8	0·4	0·8	.....	.....	19·5	0	.....	0·0	13·8	.....	.....	.....	1·9	.....	5
at BIG STONE RAPIDS, MAN.																			
1·4	8·3	1·9	0·03	3·8	0·4	0·4	.....	.....	29·8	4·8	31	0·0	17·8	71·6	46·9	.....	0·6	10·5	6
at BROCHET, MAN.																			
1·0	2·4	0·7	0·28	2·4	0·7	0·6	0·10	0·00	16·6	0	2·8	0·0	11·0	22·0	30·5	.....	2·7	12·4	7
1·8	2·2	1·1	.....	2·2	0·6	0·4	.....	0·00	17·1	0	4·1	0·0	11·4	22·4	27·2	.....	2·3	12·7	8
1·0	1·7	1·4	.....	2·7	0·3	0·2	.....	.....	15·9	0	2·6	0·0	11·4	20·6	21·9	.....	2·6	12·4	9
1·2	2·0	1·0	0·01	2·7	0·3	0·4	0·10	.....	15·1	0	3·0	0·0	10·8	20·5	34·5	.....	2·7	12·6	10
1·0	1·6	0·8	0·01	1·0	0·2	0·4	.....	.....	21·3	0	10	0·0	13·1	29·4	19·8	.....	2·5	12·1	11
LAKE at WHITESAND DAM, SASK.—Drainage area 2,200 sq. miles																			
1·0	1·9	0·6	0·02	2·0	0·1	0·1	0·10	.....	13·2	0	2·0	0·0	10·7	16·0	14·0	.....	2·7	12·7	12
1·0	1·4	1·2	.....	1·6	0·4	0·2	.....	.....	16·6	0	2·5	0·0	10·3	19·0	20·4	.....	3·0	12·8	13
1·8	2·2	1·3	.....	2·9	0·4	1·2	.....	.....	17·1	0	2·5	0·0	12·3	22·6	25·5	.....	2·6	12·5	14
1·4	1·6	1·3	0·02	1·7	0·2	0·4	0·10	.....	14·4	0	7·1	1·5	13·3	22·2	18·9	.....	2·6	12·4	15
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18
1·6	5·1	0·9	0·02	1·2	0·6	0·8	.....	.....	29·0	0	16	0·0	15·1	44·6	40·7	.....	2·0	11·5	19

TABLE V

Chemical Analyses of Municipal Water Supplies Within the Churchill River Drainage Basin

(In parts per million)

No.	Municipality	Bonnyville Alta.	Fort Churchill, Man.*	
	Source(s)	Moose Lake	Lake Isabelle	
	Sampling point	Raw and finished water Town tap	Raw water From suction well	Finished water From plant clear well
1	Date of collection	August 12/52	May 29/56	May 29/56
2	Storage period (days)	9:21	31:49	31:49
3	Sampling temperature °C	11·1	1·7	13·3
4	Test temperature °C	25·0 (17·0)	22·3	22·3
5	Oxygen consumed by $KMnO_4$		6·3	4·8
6	pH	8·7 (8·6)	7·2	7·6
7	Colour	10 (25)	20	10
8	Turbidity	1 (5)	2	0·3
9	Suspended matter dried at 105°C			
10	Suspended matter, ignited at 550°C			
11	Residue on evaporation, dried at 105°C	515	196	272
12	Ignition loss at 550°C	25·6	41·6	80·8
13	Specific conductance (micromhos at 25°C.)	745 (745)	312	352
14	Calcium (Ca)	26·9	27·2	17·9
15	Magnesium (Mg)	41·6	8·0	11·7
16	Iron (Fe) Total			
17	Dissolved	0·06	0·01	Trace
18	Manganese (Mn)		0·0	0·0
19	Sodium (Na)	77·0	25·2	27·6
20	Potassium (K)	11·1	2·5	2·5
21	Carbonate (CO_3)	22·8	0	0
22	Bicarbonate (HCO_3)	293	114	30·7
23	Sulphate (SO_4)	117	12·0	74·7
24	Chloride (Cl)	13·8	34·4	36·4
25	Fluoride (F)	0·20	0·20	0·20
26	Nitrate (NO_3)	1·4	8·0	4·8
27	Silica (SiO_2), Colorimetric	3·4	2·0	3·4
28	Carbonate hardness, as $CaCO_3$	238	93·6	25·2
29	Non-carbonate hardness, as $CaCO_3$	0	7·2	67·6
30	Total hardness, as $CaCO_3$	238	100·8	92·8
31	Sum of constituents	460	176	195
32	Saturation index	+1·1	−0·9	−1·2
33	Copper		0·0	0·0
34	Zinc		0·0	0·0
35	Aluminum		0·0	0·15

* Military Camp.

TABLE VI

Municipal Water Supplies Within the Mississippi River and Churchill River Drainage Basins in Canada

Drainage basins	Number and source of municipal systems studied					Treatment of water in municipal systems			Approximate population served with water in 1951 and in 1956*				Per cent population served with water in 1951 and in 1956*				Number of systems and population that are served with water classed as				Per cent population served with water classed as				Weighted average hardness (1951)		
	Type	Alta.	Sask.	Man.	Total	None	Chlorination	Addn. or other treatment	Alta.	Sask.	Man.	Total	Alta.	Sask.	Man.	Total	Soft	Med. hard	Hard	Very hard	Soft	Med. hard	Hard	Very hard	Alta.	Sask.	Man.
Mississippi River in Canada.	Ground	2	3	0	5	3	2	.....	1012 (1078)	2308 (2593)	.....	3320 (3671)					(1) 422 (445)	.....	.....	(4) 2898 (3226)							
	Surface	.....	1	.....	1	.....	.....	1	.....	2000 (2012)	.....	2000 (2012)	11 (12)	7 (7·7)	0 (0)	7·7 (8·3)	.....	(1) 2000 (2012)	.....	.....	8 (7·8)	37·6 (35·4)	0 (0)	54·4 (56·8)	180	420	.....
	Mixed	.....	.....	.....	0	.....	.....	.....	.....	.....	.....	.....					.....	.....	.....	.....							
Churchill River.	Ground	.....	.....	.....	0	.....	.....	.....	.....	.....	.....	.....					.....	.....	.....	.....							
	Surface	1	.....	.....	1	.....	1	.....	1250 (1482)	.....	.....	1250 (1482)	7 (6)	0	0	2·7 (2·6)	.....	.....	.....	(1) 1250 (1482)	.....	.....	.....	100	238	.....	.....
	Mixed	.....	.....	.....	0	.....	.....	.....	.....	.....	.....	.....					.....	.....	.....	.....							
Totals.....	Ground	2	3	0	5	3	2	.....	2262 (2560)	4308 (4605)	.....	6570 (7165)					(1) 422 (445)	(1) 2000 (2012)	.....	(5) 4148 (5708)							
	Surface	1	1	0	2	.....	1	1	.....	.....	.....	.....					.....	.....	.....	.....							

* Values in brackets are for 1956, others for 1951.

APPENDIX A

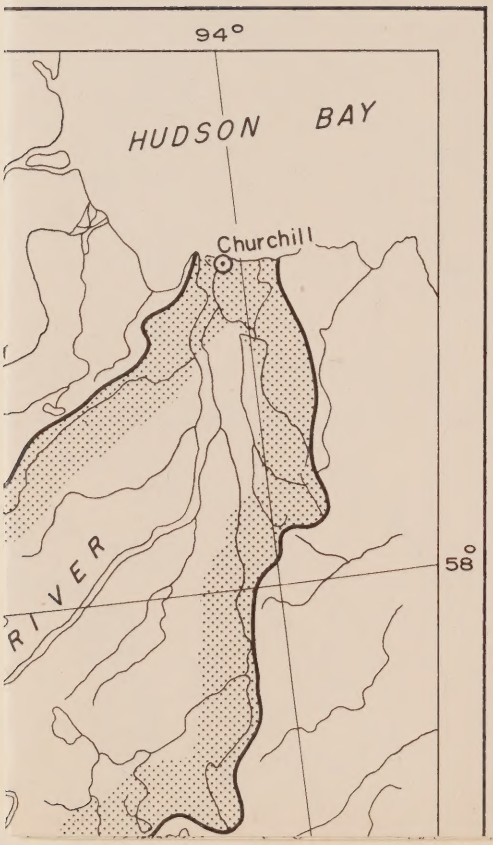
Sampling Locations of Surface Waters

Sampling Locations of Surface Waters—*concluded*

APPENDIX B

Municipalities with Organized Water Systems


CANADA
DEPARTMENT
OF
MINES AND TECHNICAL SURVEYS
MINES BRANCH
FIGURE 3
Location of
surface water sampling stations
and municipal water supplies
Churchill River drainage basin
Scale in miles
20 0 20 40
LEGEND
Municipal Supplies
Total hardness as p.p.m. CaCO3
0-60
61-120
121-180
over 180
Boundary of drainage basins
Sampling Stations
Monthly or
Quarterly sampling
Spot sampling
To accompany Mines Branch Report No. 858
Cartography by the Geographical Branch,
Department of Mines and Technical Surveys, 1958
FIGURE 2
Mississippi River drainage basin
in Canada
Scale in miles
20 0 20 40
L. ATHABASCA
HUDSON BAY
SASKATCHEWAN
MANITOBA
ALBERTA
CHURCHILL RIVER
WOLLASTON LAKE
REINDER LAKE
Churchill
Brochet
Lac Ile-a-la-Crosse
Ile-à-la-Crosse
Stanley Mission
La Ronge
Island Falls
Sherridan
Flin Flon
Brierreville
Bonnyville
Cold Lake
Goodsoil
Waterhen
Dorintosh
Meadow Lake
Loon Lake
Green Lake
Big River
Waskesiu Lake
Montreal Lake
Shaunavon
Swift Current
Morse
Chaplin
Moose Jaw
Regina
Eastend
Cadillac
Gravelbourg
Pambrun
Vanguard
Meyronne
Lafleche
Assiniboia
Pangman
Courval
Ardill
Bishopric
Verwood
Willow Bunch
Flintoft
McCord
Val Marie
Consul
Govenlock
Etzikom
Warner
Milk River
Whisky Gap
Rockglen
Kildeer
Coronach
Constance
Alma
CANADA
U.S.A.


94°
HUDSON BAY
Churchill
58°
RIVER